

## **SPECIAL PROVISIONS**

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### **1. SCOPE OF WORK**

This project includes the installation of a concrete cover over Tillet Spring, a diversion structure, two aeration structures, piping interconnecting the spring with the structures and existing hatchery building and piping inside the hatchery building.

### **2. SAFETY STANDARDS**

The Contractor shall be solely and completely responsible for conditions of the jobsite, including safety of all persons (including employees) and property during performance of the work. This requirement shall apply continuously and not be limited to normal working hours. Safety provisions shall conform to U.S. Department of Labor (OSHA), and all other applicable Federal, State, County, and Local laws, ordinances, codes and regulations. Where any of these are in conflict, the more stringent requirement shall be followed. The Contractor's failure to thoroughly familiarize himself with the aforementioned safety provisions shall not relieve him from compliance with the obligations and penalties set forth therein.

The Contractor shall develop and maintain for the duration of this Contract a safety program that will effectively incorporate and implement all required safety provisions. The Contractor shall appoint an employee who is qualified and authorized to supervise and enforce compliance with the safety program.

The duty of the Engineer to conduct construction review of the work does not include review or approval of the adequacy of the Contractor's safety program, safety supervisor, or any safety measures taken in, on or near the construction site.

The Contractor, as a part of his safety program, shall maintain at his office or other well-known place at the jobsites, safety equipment applicable to the work as prescribed by the aforementioned authorities, all articles necessary for giving first-aid to the injured, and shall establish the procedure for the immediate removal to a hospital or a doctor's care of persons (including employees) who may be injured on the jobsite.

If death or serious injuries or serious damages are caused, the accident shall be reported immediately by telephone or messenger to both the Engineer and the Owner. In addition, the Contractor must promptly report in writing to the Engineer all accidents whatsoever arising out of, or in connection with, the performance of the work whether on, or adjacent to, the site, giving full detail and statements of witnesses.

If a claim is made by anyone against the Contractor or any subcontractor on account of any accident, the Contractor shall promptly report the facts in writing to the Engineer, giving full details of the claim.

The Contractor shall take all necessary provisions for safe handling of chemical amendments and potentially hazardous wastes, including apprising himself of hazards, developing safety plans, providing emergency and decontamination services, and developing spill containment procedures.

### **3. PROJECT MEETINGS**

Pre-Construction Conference. After the Contract has been awarded, but before the start of construction, a pre-construction conference will be held at a time and place mutually agreed to by the parties. The conference shall be attended by the following: the Contractor and his superintendent; the principal subcontractors; representatives of principal suppliers and manufacturers, as appropriate; the Engineers and his construction observer; representatives of the Owner and others as appropriate.

Unless previously submitted, the Contractor shall bring the following submittals to the conference: list of proposed Subcontractors; proposed construction schedule; schedule for submitting shop drawings and other submittals; schedule procurement dates; construction technique submittal forms (as applicable); preliminary payment schedule; and tentative schedule of values. Work shall not start prior to the Engineer's receipt of these submittals. The Engineer will preside at the conference and will arrange for keeping the minutes and distributing copies of the minutes to all persons attending the meeting.

### **4. UTILITIES AND BARRIERS**

Notification. The Contractor shall contact the one call locate number in advance of performing any excavation work on the site to obtain utility locates over the entire area to be impacted by construction of the project. The Contractor shall immediately notify the Engineer of the discovery of any utilities that are in conflict with the work that were not previously identified in the plans.

Identification. All utilities that may conflict with the work shall be the Contractor's responsibility to locate before any excavation is performed. Field markings provided by the utilities shall be preserved by the Contractor until actual excavation commences. All utility locations on the Drawings should be considered approximate and should be verified in the field by the Contractor. The Contractor shall also be responsible for locating all utilities that are not located on the Drawings.

Temporary Utilities. The Contractor shall provide all temporary electrical, lighting, telephone, heating, cooling, ventilating, water, sanitary, first aid, fire protection, and other utilities and services necessary for the performance of the work. All fees, charges, and other costs associated therewith shall be paid for by the Contractor.

Conflicts with Existing Utilities. For any utilities shown on the plans which are damaged or require temporary support to allow performance of the work, the Contractor shall contact the utility's owner and make all arrangements and pay all costs associated with the repair and/or temporary support of the utility. The Contractor shall comply with all requirements of the utility's owner.

The Contractor is responsible for the repair of any utilities that were properly marked by the utility locator and damaged by the Contractor, whether they are shown on the plans or not.

Barriers. The Contractor shall temporarily remove all fences, barricades, minor structures, and other obstructions that interfere with the prosecution of the work. Removal shall not extend beyond designated construction limits or right-of-way without first obtaining written authorization from the owner of the barrier.

Fences and barricades used for the confinement or exclusion of livestock, animals, or persons shall be replaced at the end of each work day to the extent necessary to perform the restrictive intent of the barrier.

Unless otherwise directed by the Engineer or indicated on the Drawings, all barriers so removed shall be replaced following the completion of the work to as good or better condition than existed prior to the start of work. The requirement applies to small trees and decorative shrubs as well as fences, barricades, and minor structures.

The Contractor shall replace at his own expense all barriers damaged or destroyed.

## **5. REPAIR AND REPLACEMENT QUALITY**

General. Items requiring repair or replacement due to damage or removal or otherwise necessitated in the course of pursuance of the work and which are not otherwise specified herein, shall be repaired or replaced to the following levels of quality.

Paved and Gravel Roads, Driveways, and Sidewalks. Repair or replacement shall be to a thickness and grade matching the existing condition. Quality of materials and methods shall

comply with respective sections of the current edition of the Montana Public Works Standard Specifications.

Water and Sewer Main and Services. Repair or replacement shall be in a manner consistent with the existing condition using materials conforming to the Uniform Plumbing Code, the current editions of the DEQ 1 and DEQ 2 circulars, American Water Works Association Standard Specifications, and the requirements of the Montana Department of Environmental Quality. Construction shall also comply with the current edition of the Montana Public Works Standard Specifications. Repair or replacement will not be allowed with materials like the existing installation if they do not conform to the above-referenced standards.

Electrical, Telephone, Cable TV, Natural Gas, and Petroleum Lines. Repair or replacement shall be to the standards required by the utility owner and at the utility owner's option may be performed by the utility owner with full cost assessed to the Contractor.

Fences. All fences adjacent to any work site are to be maintained to the satisfaction of the abutting property owners. The Contractor shall notify the landowners of the need to temporarily removed or relocate fences for access to the work and shall coordinate such activities with the respective landowners in regards to removal, relocation, and restoration of fences prior to commencing work.

Any fence removed or destroyed during the course of the Contract shall be reinstalled or reconstructed in like kind at no cost to the Owner or the landowner. The cost for this work shall be considered incidental and no additional compensation will be allowed.

Other Items. Repair or replacement of other items not covered by the preceding shall be to the standards required by the owner of the item and at the owner's option may be performed by the owner of the item with full cost assessed to the Contractor.

Decisions Regarding Repair Versus Replacement. The decision of repair versus replacement of an affected item shall be at the discretion of the Engineer upon consultation with the owner of the item. The decision shall be based on a determination of whether repaired quality can equal the quality of a replacement installation. The Engineer's authority shall be final in this regard.

Limits of Repair and Replacement. The limits of areas to be repaired or replaced shall be determined by the Engineer in the field based on the extent of damage or removal sustained. The determination shall be based on insuring that all damaged or removed portions of the existing installation are fully restored. The authority of the Engineer shall be final in this regard. All work effects outside limits as described in these Contract Documents are subject to repair and replacement quality as described herein.

Repair by Party Owning or Maintaining Item. The party owning or maintaining the item under consideration shall have the exclusive right to undertake repair or replacement themselves and charge the Contractor for full costs incurred or to direct and supervise the Contractor to repair or replace the item to their standard of quality. The authority of the owner of the item shall be final in this regard.

## **6. GENERAL CONSTRUCTION REQUIREMENTS**

Quality Assurance. The Engineer will monitor the construction of work covered by this section to determine if the work is being performed in accordance with the contract requirements. The Engineer does not have the authority or the means to control the Contractor's methods of construction. It is, therefore, the Contractor's responsibility to utilize all methods, equipment, manpower, and other means necessary to assure that the work is installed in compliance with the Drawings and Specifications, and laws and regulations applicable to the work. All buried work items shall be installed in the presence of the Engineer or may not be considered for payment.

Grade and Alignment. The Contractor shall provide all construction staking as required to define the locations of the roadway, building, retaining wall and underground utilities to be installed under this contract.

Tolerances. Construction tolerances for the work shall be as outlined in the Technical Specifications.

Construction Limits. Construction limits shall be no more than 50 feet from any edge of excavation and embankment, pipe, or any other improvements shown on the plans. Otherwise all equipment access is allowed along existing roads. Disturbance and equipment access beyond these limits is not allowed without the written approval of both the Engineer and the Owner of the affected property. If so approved, disturbance beyond construction limits shall meet all requirements imposed by the landowner; this includes existing roads used and/or improved as well as the construction of new access roads. Special construction, reclamation, or post-construction road ripping or other closure provisions required by the landowner on access roads beyond the construction limits shall be performed by the Contractor at no additional cost to the Owner.

Areas of Disturbance. Approved areas of disturbance are those areas disturbed by construction activities within the construction limits and along designated or approved access routes. Such areas shall be fine graded to blend with the existing terrain. Other areas that are disturbed by the Contractor's activities outside the limits noted above will be considered as site damage or unapproved areas of disturbance subject to the repair and replacement quality as specified herein. Such areas will also require the reclamation operations noted above and as specified herein, but costs of such work shall be borne by the Contractor. This includes areas selected by the Contractor outside the defined construction limits for mobilization, offices, equipment, or material storage.

## **7. ENGINEERING INTERPRETATIONS**

Engineering Decisions. It is realized that timely engineering decisions on construction activities or results have an important bearing on the Contractor's schedule. On this project, the Engineer will make every effort to have a Project Inspector readily available to the project during the construction schedule, who has the authority to make judgement calls on matters dealing with interpretation of the plans and specifications, with one qualification: that he shall have the right to take twenty-four (24) hours to confer with other Engineers before giving said decision.

When the decision affects a plan design or specification change, it should be realized that more time may be required than twenty-four (24) hours to gain the necessary Owner and funding source participation in the decision process including time for formal change order preparation as required.

## **8. REJECTED WORK**

Any defective work or nonconforming materials or equipment that may be discovered at any time prior to the expiration on the warranty periods shall be removed and replaced by work which shall conform to the provisions of the Contract Documents. Any material condemned or rejected shall be removed at once from the project site. Failure on the part of the Engineer to condemn or reject bad or inferior work or to note nonconforming materials or equipment on Contractor's submittals shall not be construed to imply acceptance of such work. The Owner shall reserve and retain all its rights and remedies at law against Contractor and its Surety for correction of any and all latent defects discovered after the guarantee period.

The Engineer will have the authority to reject work that does not conform to the Contract Documents and will provide the Owner with a list of defective work and nonconforming materials of equipment. The Owner will then promptly provide the Contractor with the list of defective work and nonconforming materials or equipment.

## **9. QUALITY CONTROL**

Scope. All work will be tested and inspected to insure compliance with the Contract Documents. Complete payment will not be made until the Contractor has demonstrated that the work is complete and will perform as required.

Performance of Tests and Inspections. The Contractor, Owner, Engineer, and representatives of funding and regulatory agencies will perform periodic inspections and tests to determine compliance with the Contract Documents. The Contractor shall provide qualified manufacturer's representation during tests of equipment and special procedures as required by the Contract Documents.

Notification. The Contractor shall provide the Engineer with a written schedule indicating dates for specific testing and inspection services to be performed. The schedule shall be updated as required to give the Engineer at least a week's advance notice. The Contractor shall notify the Engineer immediately of any change or shall be subject to pay engineering fees as herein described.

Inspection. The Contractor shall inspect the work as it is being performed. Any deviation from the requirements shall be immediately corrected. Prior to any scheduled inspection by the Engineer, the Contractor shall again inspect the work and certify to the Engineer that he has inspected the work and it meets the requirements of the Contract Documents.

The Engineer's representative will observe work and compare the quality of the work with the requirements of the Contract Documents. Any discrepancies noted shall be brought to the Contractor's attention, who shall immediately correct the discrepancy. Failure of the Engineer to detect a discrepancy will not relieve the Contractor of his ultimate responsibility to perform the work as required.

Should the Engineer incur additional costs to make additional observation as a result of unacceptable work, the Contractor shall reimburse the Owner for additional engineering fees at the Engineer's rates at the time.

Observation by the Engineer's representative shall not be considered as authorization to proceed with the work. Work progress and the performance of quality work are the Contractor's responsibility. The Engineer's observation is for the purpose of determining what work will be paid for and what work will not be paid for. If the Engineer detects a discrepancy between the work and the requirement of the Contract Documents at any time, up to and including final inspection, such work will not be completely paid for until the Contractor has corrected the deficiency.

The work will be subject to review by the Owner and funding agency representatives whose findings shall be as valid as those of the Engineer. The results of all such observations shall be directed to the Contractor through the Engineer.

Equipment and System Tests. The Contractor shall provide all equipment, materials, supplies, manufacturer's representation, and incidentals necessary to perform tests on completed work. The Contractor shall notify the Engineer, in advance, when, where, and on what portion of the work a test will be performed and shall perform the test in the presence of the Engineer. The Engineer's presence during the test will not relieve the Contractor of his responsibility to provide equipment and systems meeting all the requirements of the Contract Documents and to warrant the work as required.

Should any tests performed in the presence of the Engineer fail to meet the requirements of the Contract Documents or should the Contractor fail to provide adequate notice of a change in scheduling tests, the Contractor shall reimburse the Owner for additional engineering fees resulting there from.

## **10. CONSTRUCTION SURVEYS**

The following construction staking shall be provided by the Owner:

1. A two point base line along the center axis of the structure with offsets to the face of structure will be provided for the hatchery building aeration structure, the first pass aeration structure, and the diversion structure.
2. Four points shall be placed to define the Tillet Spring Cover structure. Points will be placed in a square at the intersection of the extension of the face of the four long walls.
3. A benchmark will be placed with 100-feet of each structure.

4. Piping will be staked on centerline at maximum 100-foot intervals on tangents and 25-foot intervals on curves. All bends and curve points will also be staked.

Any additional staking necessary to construct the project will be provided by the Contractor including any required referencing the staking listed above. It is the Contractor's responsibility to protect the stakes. The restaking of any points lost will be the responsibility of the Contractor.

## **11. FIELD ENGINEERING**

Engineering Services Provided by the Owner. The Owner shall provide the following engineering services at no cost to the Contractor except as required for certain tests and retests as defined in the Contract Documents.

Review of submittals and shop drawings as defined in the Specifications.

Periodic inspections by the Engineer and its representative(s) as deemed appropriate by the Owner and Engineer.

Independent Services Provided by the Contractor. The Contractor shall provide the following services at no additional cost to the Owner.

Field Density Testing of materials as required per the Technical Specifications. Testing shall be provided by a certified independent testing laboratory. Testing frequencies shall be as follows:

Water Trench Backfill – 24 tests total.

Structural Embankment – total of 2 tests for each aeration structure and diversion structure, 6 test for Tillet Spring Cover Structure.

Structural Backfill - total of 4 tests for each aeration structure and diversion structure, 8 test for Tillet Spring Cover Structure.

Concrete and shotcrete testing as specified.

Preparation and certification of all required shop drawings and submittals.

Performance of certain tests as required by the Contract Documents.

Maintenance of project drawings, accurately marked up with changes.

Design of all temporary construction falsework, bracing, shoring, support, or other structural work necessary for the permanence of the work.

Engineering Services Paid for by the Contractor. The Contractor is advised that certain engineering services required by the Contract Documents will be performed by the Engineer and paid for by the Contractor.

In general, these services include retests by the Engineer of tests that have failed, repeated review of submittals and shop drawings that have not been approved, and other services that are within the Contractor's control to avoid.

Payment of engineering services shall be made by invoice to the Contractor or deducted from partial payments, whichever is necessary.

## **12. WEATHER DAYS**

Weather Days. In the event inclement weather or the aftermath of inclement weather prevents the Contractor from performing the sequence of operations that should be in progress at that time for a minimum of 60% of the normal daily schedule being worked, he may request a time credit for that day. No credit for inclement weather will be allowed on non-working days (Saturday, Sunday, and Holidays).

Determination of the number of credit days will be made between the Contractor and the Engineer at the end of each calendar month.

## **13. MATERIAL SOURCES**

If additional material is needed trench backfill, embankment or other materials, the Contractor will be responsible for placement and import from a designated on site location. If the material excavated for the trench meets the required specifications, it may be used and installed per specifications. Topsoil shall be stripped, stockpiled and replaced per specifications over disturbed areas. Supplemental topsoil may be imported at the discretion of the Owner/ Engineer.

If excess material is generated during construction, it shall be exported and disposed of in an on-site location designated by the Owner.

All areas utilized for material sources or excess material shall be fine graded to blend with existing terrain, topsoiled and reseeded. Haul routes shall be within the corridors of disturbance created by this project.

## **14. ENVIRONMENTAL PROTECTION**

The Contractor shall comply with all laws and regulations of the United States Corps of Engineers and Environmental Protection Agency, Montana Department of Fish, Wildlife and Parks, Department of State Lands, Department of Environmental Quality, the Department of Natural Resources and Conservation, and with all other Federal, State, and Local laws and regulations controlling pollution of the environment. He shall take necessary precautions to prevent pollution of streams, lakes, ponds, and reservoirs with fuels, oils, bitumens, chemicals, or other harmful materials and to prevent pollution of the atmosphere from particulate and gaseous matter.

The Contractor also agrees to comply with the requirements of any permits obtained for the project by the Owner. These permits include but may not be limited to the permits listed under

the Permits and Regulatory Requirements section. Copies of any of these permits are available upon request from the Engineer.

The Contractor shall be responsible for submitting and obtaining a temporary discharge permit from the Montana Department of Environmental Quality for the discharge of any water related to the construction of this project. A construction Dewatering Discharge Permit, issued by the Department of Environmental Quality, is required if water from construction is discharged to state waters. The Department of Environmental Quality must be contacted immediately if either contaminated soil or contaminated groundwater is encountered.

The Contractor shall be responsible for submitting and obtaining a storm water discharge permit from the Montana Department of Environment Quality. The cost of any erosion control measures or other work required by the permit shall be included in the bid and are considered incidental to the project.

## **15. WEED CONTROL**

Prior to mobilizing equipment to the project site, the Contractor shall clean his equipment and vehicles to assure no weeds are imported. If there is an abnormal growth of noxious weeds on a project site after construction as determined by the Owner or local weed control authority, the Contractor may be responsible for weed control under the contract warranty.

## **16. PERMITS AND REGULATORY REQUIREMENTS**

Jurisdiction. The performance of this work shall be under the jurisdiction of the following agencies, departments, and standards and compliance with the requirements thereof is required:

**Federal Level:** United States Law

**State Level:** Department of Environmental Quality; Department of Fish, Wildlife & Parks; Montana Department of Transportation; Montana Building Code Division; Uniform Building Code; Uniform Plumbing Code; Uniform Mechanical Code; National Electric Code; State annotations to these codes; and Montana State Law.

**Local Level:** Carbon County

Contractor's Responsibility. The Contractor shall familiarize himself with the requirements of all regulatory agencies pertaining to the performance of the work on the project.

The Contractor shall secure and pay for all permits, licenses, and fees necessary for the performance of the work.

The Contractor shall perform all work in accordance with the regulatory requirements. Any conflict between the Contract Documents and the regulatory requirements shall be brought to the immediate attention of the Engineer.

The following permits will be required for construction:

<b>Permit</b>	<b>Entity Providing Permit</b>	<b>Entity Submitting Permit</b>
SWPPP	MDEQ	Contractor
Dewatering Discharge Permit	MDEQ	Contractor
Montana Stream Protection Act (SPA 124)	FWP	Owner
Federal Clean Water Act (404)	USACE	Owner
Short Term Water Quality Standards for Turbidity (318 Authorization)	DEQ	Owner

## **17. SMOKE AND DUST CONTROL**

The Contractor shall have informed himself of all applicable State Board of Health requirements and similar State or Federal requirements pertaining to control of or abatement of air pollution. The Contractor shall have provided or be prepared to provide such air pollution control measures as are required to comply with the minimum standards established by such agencies.

Hauling of material and transport of equipment along public roadways or through the towns and adjacent other structures and dwellings shall require effective dust abatement procedures. This also applies to the unloading and placement of spoils material at deposition sites. The Contractor shall utilize environmentally sound methods for watering and/or otherwise chemically treating dust-generating surfaces to comply with all applicable legal standards for airborne particulates. Prior to any work, the Contractor shall submit a written plan for dust abatement procedures identifying at a minimum the following:

- Times and nature of dust generating activity on public roads and at deposition sites.
- Nature and chemical characterization of dust abatement materials to be used.
- Method of application of dust abatement materials to be used.
- Time schedule for application of dust abatement materials to be used.
- Availability of equipment and operators for emergency application of dust abatement materials at other than scheduled times.

Watering for dust control is considered incidental to the Contract and shall be performed at no additional cost to the Owner.

## **18. USE OF COMPLETED PORTIONS**

The Owner shall have the right to take possession of and use any completed or partially completed portions of the work, notwithstanding that the time for completing the entire work or such portions may not have expired; but such taking possession and use shall not be deemed an acceptance of any work not completed. If such taking possession and use of incomplete work causes refinishing of completed work, the Contractor shall be entitled to such extra compensation or extension of time or both, as agreed by the Owner.

## **19. WARRANTY**

The Contractor shall warranty all materials and equipment furnished and work performed for a period of one year from the date of final city acceptance. The Contractor warrants and guarantees for a period of one year from the date of final acceptance of the project that the project is free of all defects due to faulty material or workmanship and the Contractor shall promptly make such corrections as necessary by reason of such defects including repair or damage to other parts of the project resulting from such defects. The Owner will give notice of observed defects with reasonable promptness. In the event the Contractor should fail to make such repairs, adjustments, or other work that may be made necessary by such defects, the Owner may repair the defects and charge the Contractor the cost thereby incurred. The performance bond shall remain in full force for a period of one year after final acceptance.

## **20. CONTRACT DOCUMENT DISCREPANCIES**

In the event that a provision of the Contract Documents conflicts with any other provision the Contract Documents, the provision in that Contract Document first listed below shall govern, except as otherwise specifically stated:

- Agreement
- Addenda to Contract Documents
- Performance and Labor and Materials Bond
- Proposal (bid)
- Bid Security
- Bid Provisions
- Invitation to Bid
- Instructions to Bidders
- Drawings
- Special Provisions
- Technical Specifications
- Supplementary Conditions
- General Conditions

## **21. SITE CLEANUP**

Before final acceptance is made, the entire work area shall be cleaned and conditioned. This shall consist of the following:

- Grease, oil, grit, dirt, grime, debris, and other foreign materials shall be removed;
- Nicks, scratches, voids, holidays, and other imperfections in painted surfaces shall be touch-up painted with matching paint;
- Chips, voids, cracks, and other imperfections in exposed concrete shall be repaired with methods and materials approved by the Engineer;
- Threaded fasteners shall be checked for tightness;
- Doors, windows, hatches, and other mating surfaces shall be adjusted to fit square in their respective framework;
- Driveways and parking areas shall be fine-graded;

- Landscaping shall be fine-graded.

At the completion of this Contract, before acceptance of the work by the Owner, the Contractor shall remove all of his equipment, tools, and supplies from the property of the Owner. Should the Contractor fail to remove such equipment, tools, and supplies, the Owner shall have the right to remove them at the Contractor's expense and deduct all resulting costs from the final payment.

## 22. SANITARY FACILITIES

Sanitary facilities shall be provided and maintained by the Contractor who will comply with state and local regulations. The cost of furnishing, installing, and maintaining sanitary facilities shall be considered incidental to other items of work and no additional compensation will be allowed.

## 23. MEASUREMENT AND PAYMENT

- A. **Scope:** This section describes the method of measurements and the basis of payment for all work shown on the drawings and required by the Contract Documents. This measurement and payment section shall take precedence over all other references to measurement and payment referenced in these specifications (with the exception of any addenda).

- B. **Bid Prices:** The bid price for each item of the Contract in the Bid Proposal shall cover all work shown on the drawings and be defined in the specifications and other contract documents. All costs in connection with the work including furnishing all materials, equipment, and tools, and performing all necessary labor and supervision to fully complete the work, shall be included in the lump sum or unit price bid items on the proposal. The amounts shown on the proposal shall be the contract price.

No item that is required by the Contract Documents for the proper and successful completion of the work will be paid for outside of or in addition to the prices submitted in the Bid Proposal. All work not specifically set forth as a pay item in the Bid Proposal shall be considered a subsidiary obligation of the Contractor and all cost in connection therewith shall be included in the prices bid.

Retainage at the amounts specified in the General Conditions will be withheld from each progress payment.

- C. **Estimated Quantities:** Any estimated quantities stipulated in the Bid Proposal or other Contract Documents are approximate and are to be used only as a basis for estimating probable cost of the work and for the purpose of comparing the bids submitted for the work.
- D. **Method of Measurement:** No measurement will be made on bid items representing a lump sum bid.

E. **Basis of Payment:**

**1. Mobilization, Insurance & Bonding**

- ♦ General: This bid item shall include the costs associated with mobilizing to the project site, insurance, permitting, and submittals.
- ♦ Work Included:
  - All labor, tools, equipment, materials, royalties, and incidentals needed to complete the work as specified;
  - Transport and set up all equipment, materials, and other items needed to complete the project;
  - All permits, coordination, and compliance inspections required for the work;
  - Insurance;
  - Prepare and provide submittals, construction schedule, and all other paperwork required by the contract documents prior to construction startup.
  - Remove all equipment from the site and site cleanup at project completion.
- ♦ Measurement: Measurement shall be one lump sum bid item.
- ♦ Payment: Payment shall be by the price bid for the lump sum bid item listed in the proposal. Allowable payments are 50% of the total bid for this item when moved to the site, 25% when the project is 50% complete, and the balance when the project is complete.

**2. Hatchery Building Piping**

- ♦ General: This bid item shall include the installation of piping and appurtenances inside the existing hatchery building including the pipe penetrations through the hatchery building wall.
- ♦ Work Included:
  - All labor, tools, equipment, materials, and incidentals needed to complete the work as specified;
  - Provide and install pipe, fittings, valves and pipe supports;
  - Provide equipment to join HDPE pipe;
  - Remove and reset tanks and equipment interfering with construction;
  - Core the foundation wall in two locations;

- Sealants at pipe penetrations.
- ♦ Measurement: Measurement shall be one lump sum bid item.
- ♦ Payment: Payment shall be by the price bid for the lump sum bid item listed in the proposal.

### **3. Hatchery Building Aeration Structure**

- ♦ General: This bid item shall include the construction of the complete Hatchery Building Aeration Structure.
- ♦ Work Included:
  - All labor, tools, equipment, materials, and incidentals needed to complete the work as specified;
  - Excavation and backfill;
  - Dewatering as required;
  - Provide and place structural base material;
  - Provide concrete including placing, forming, reinforcing and waterstop;
  - Concrete materials testing and leak testing of structure;
  - Pipe penetrations through concrete walls;
  - Above grade HDPE piping, fittings and appurtenances supplying the aeration columns;
  - Below grade HDPE piping fittings and appurtenances limited to the vertical run of pipe adjacent to the structure and the buried 90 degree fitting;
  - Small diameter HDPE piping between the structure and the vertical 90 degree bend;
  - Aeration column and aeration column supports;
  - Fiberglass grating, supports and embedment angles;
  - Aluminum channel embed and redwood dam boards;
  - Aluminum pipe strap.
- ♦ Measurement: Measurement shall be one lump sum bid item.
- ♦ Payment: Payment shall be by the price bid for the lump sum bid item listed in the proposal.

### **4. First Pass Aeration Structure**

- ♦ General: This bid item shall include the construction of the complete First Pass Aeration Structure.

- ♦ Work Included:
  - All labor, tools, equipment, materials, and incidentals needed to complete the work as specified;
  - Excavation and backfill;
  - Dewatering as required;
  - Provide and place structural base material;
  - Provide concrete including placing, forming, reinforcing and waterstop;
  - Concrete materials testing and leak testing of structure;
  - Pipe penetrations through concrete walls;
  - Above grade HDPE piping, fittings and appurtenances supplying the aeration columns;
  - Below grade HDPE piping fittings and appurtenances limited to the vertical run of pipe adjacent to the structure and the buried 90 degree fitting;
  - Small diameter HDPE piping between the structure and the vertical 90 degree bend;
  - Aeration column and aeration column supports;
  - Fiberglass grating, supports, and embedment angles;
  - Aluminum pipe strap.
- ♦ Measurement: Measurement shall be one lump sum bid item.
- ♦ Payment: Payment shall be by the price bid for the lump sum bid item listed in the proposal.

## 5. Diversion Structure

- ♦ General: This bid item shall include the construction of the complete Diversion Structure.
- ♦ Work Included:
  - All labor, tools, equipment, materials, and incidentals needed to complete the work as specified;
  - Excavation and backfill;
  - Dewatering as required;
  - Provide and place structural base material;
  - Provide concrete including placing, forming, reinforcing and waterstop;
  - Concrete materials testing and leak testing of structure;
  - Pipe penetrations through concrete walls;
  - Fiberglass grating, supports and embedment angles;
  - Aluminum channel embed and redwood dam boards;
- ♦ Measurement: Measurement shall be one lump sum bid item.

- ♦ Payment: Payment shall be by the price bid for the lump sum bid item listed in the proposal.

## 6. Tillet Spring Cover Structure

- ♦ General: This bid item shall include the construction of the complete Tillet Spring Cover Structure.
- ♦ Work Included:
  - All labor, tools, equipment, materials, and incidentals needed to complete the work as specified;
  - Excavation and backfill;
  - Provide and place structural base material;
  - Provide concrete including placing, forming, and reinforcing;
  - Provide and set Hollow Core Panels;
  - Shotcrete as specified;
  - Concrete materials testing;
  - HDPE piping inside the structure from the face of the foundation wall;
  - Overflow openings, screens and frames;
  - Precast concrete supports for hatches;
  - Aluminum hatches;
  - Stain/dye and seal structure.
- ♦ Measurement: Measurement shall be one lump sum bid item.
- ♦ Payment: Payment shall be by the price bid for the lump sum bid item listed in the proposal.

## 7-9. DR 17 HDPE Piping

- ♦ General: This bid item shall include the installation of DR 17 HDPE piping of the size indicated on the bid form.
- ♦ Work Included:
  - All labor, tools, equipment, materials, royalties, and incidentals needed to complete the work as specified;
  - Connection to existing manholes;
  - Utility bracing / support and coordination with Utility Owners;
  - Dewatering as required;
  - Disposal of existing pipe as required;

- Provide compaction testing from an independent testing firm;
  - Clearing, grubbing, topsoil stripping and stockpiling;
  - Survey as required to maintain alignment and grade from stakes provided by the Owner;
  - Repair and replacement of any items not specifically mentioned elsewhere in these specifications;
  - Trench excavation and backfill;
  - Fusion machines required to make pipe connections;
  - Electro fusion couplings where required.
  - Type 1 bedding;
  - Type 2 bedding;
  - Exploratory excavation and existing utility crossings;
  - Remove spoils generated by pipe installation;
  - Provide and install pipe;
  - Required testing of pipe;
  - Flushing;
  - Grouting of 8-inch pipe into existing collection box;
  - Provide material to insure adequate pipe cover;
  - Repair of irrigation drain line;
  - Fine grading.
- ♦ Measurement: Measurement shall be per lineal foot of pipe installed including fittings. Measurement shall be to the nearest foot.
- Piping shall be measured from the face of structures and from the upstream joint of any buried vertical 90 degree bend directly adjacent to an aeration structure. Any pipe excluded will be paid as a part of other bid items.
- ♦ Payment: Payment shall be by the unit price bid per lineal foot of pipe listed in the proposal.

#### **10. 8" Pipe Penetration at Existing Aeration Structure**

- ♦ General: This bid item shall include coring and sealing of a pipe penetration at the existing aeration structure.
- ♦ Work Included:
  - All labor, tools, equipment, materials, and incidentals needed to complete the work as specified;
  - Core wall;
  - Provide and install "link seal" type product.
- ♦ Measurement: Measurement shall be one lump sum bid item.

- ♦ Payment: Payment shall be by the price bid for the lump sum bid item listed in the proposal.

## **11. 16' Farm Gate**

- ♦ General: This bid item shall include the installation of 16-foot farm gates.
- ♦ Work Included:
  - All labor, tools, equipment, materials, and incidentals needed to complete the work as specified;
  - Provide and install gate, gate hardware and closures;
  - Provide and install single panel as required on both sides of gate.
- ♦ Measurement: Measurement shall be per each gate installed.
- ♦ Payment: Payment shall be by the unit price bid for each gate installed listed in the proposal.

## **12. Barbed Wire Fence**

- ♦ General: This bid item shall include the installation of barbed wire fence.
- ♦ Work Included:
  - All labor, tools, equipment, materials, and incidentals needed to complete the work as specified;
  - Provide and install fence posts, panels, wire ;
  - Provide and install single panel as required on both sides of gate.
- ♦ Measurement: Measurement shall be per lineal foot of fence installed. Measurement shall be to the nearest foot. Single panels paid under the farm gate bid item are excluded from measurement.
- ♦ Payment: Payment shall be by the unit price bid per lineal foot of barbed wire fence listed in the proposal.

### 13. Final Grading and Seeding

- ♦ General: This bid item shall include placement of top soil, fine grading, seeding, and mulch over all areas disturbed by construction.
- ♦ Work Included:
  - All labor, tools, equipment, materials, and incidentals needed to complete the work as specified;
  - Fine grading of site;
  - Place topsoil;
  - Seeding and mulch;
  - Care of seed and mulch as specified.
- ♦ Measurement: Measurement shall be one lump sum bid item.
- ♦ Payment: Payment shall be by the price bid for the lump sum bid item listed in the proposal.

### 24. GEOTECHNICAL CONDITIONS

A geotechnical investigation was not completed specifically for this project. Soils are generally classified as clay topsoil over alluvial clays and silty sand tufa. Rock outcroppings are near the surface in isolated portions of the project site. A geotechnical report from a previous project with borings within the project area is enclosed in the Bid Documents following the Special Provisions. Contractors may use this information in preparation of their bid.

Two peizometers are located near the Tillet Spring Pipe Alignment, one about 60-foot left of station 5+10 and the other about 35-foot left of station 6+20. The water elevation in the west peizometer (near station 5+10) was 5.6-feet below ground surface while the elevation in the east peizometer (near station 6+20) was 5.7-feet below ground surface on November 5, 2012.

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DESIGN & CONSTRUCTION  
DEPT. OF FISH, WILDLIFE & PARKS

received  
8/18/99

**A Geotechnical Evaluation Report for  
Robert Peccia & Associates**

Bluewater Springs Hatchery Improvements  
East of Bridger, Montana

Project 991097  
August 17, 1999

SK Geotechnical Corporation

#2

August 17, 1999

Project 991097

Ms. Nancy Granger Cormier (3)  
Robert Peccia & Associates  
P. O. Box 5653  
Helena, Montana 59604

Dear Ms. Cormier:

Re: Geotechnical Evaluation, Bluewater Springs Hatchery Improvements, East of Bridger, Montana

The geotechnical evaluation authorized by your firm on July 22, 1999, has been completed. The purpose of the evaluation was to assist your firm, Taylor Architects and MT Structural Consultants in designing foundations and slabs, and in preparing plans and specifications for construction of the proposed hatchery improvements. The evaluation was completed in general accordance with our proposal to you dated July 15, 1999.

### Summary of Results

Twelve soil borings and two hand auger borings were conducted within the hatchery area. The general soil profile encountered by the borings was up to 1 foot of organic clay topsoil underlain by medium to very soft alluvial clays and very loose to loose silty sand tufa. Existing fill was encountered in five of the borings to depths ranging from 1/2 to 4 1/2 feet. Near Bluewater Spring, groundwater was encountered at a depth of about 3 feet. Elsewhere, groundwater was encountered in the borings at depths ranging from 6 1/2 to 14 1/2 feet.

Laboratory classification tests were conducted to confirm our visual classifications of the soils. We also performed three Proctors on bag samples collected from the borings for evaluation of soils likely to be reused during construction. Laboratory corrosion tests were also conducted and indicated the alluvial clays and silty sand tufa were corrosive to metallic conduits and concrete. Consolidation tests indicated the soft alluvial clays were moderately to highly compressible under the anticipated foundation loads.

### Summary of Analysis and Recommendations

We recommend all existing fill be removed from beneath the proposed structures. It appears some existing fill has been placed around Bluewater Spring to assist in raising grades. During construction of the canopy foundation, it will be necessary to subexcavate the existing fill from beneath the proposed foundations, and replace it with compacted structural backfill.

The anticipated footing subgrade in the hatchery building and some of the canopy will be soft alluvial clays. To increase bearing capacity and reduce settlement, we recommend subexcavating a minimum of 2 feet beneath the proposed hatchery building column footings and the canopy footings where the soft clays are encountered. We then recommend placing a geotextile directly on the soft subgrade and then placing 2 feet of compacted structural backfill beneath the footings. Some dewatering will likely be required during subexcavation and installation of the canopy footings.

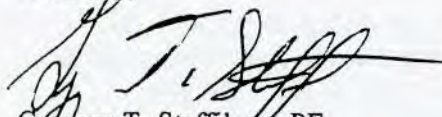
The anticipated subgrade in the proposed raceways will be lean clay and silty sand. These soils are moderately to highly frost-susceptible. During the winter, these soils can freeze and heave the raceway slabs several inches. This could result in cracks in the concrete and increase water seepage, which could make the problem worse. If the raceways will be left dry for extended periods during the winter, we recommend providing 3 feet of nonfrost-susceptible sand or sandy gravel backfill beneath and around the raceways. Another alternative is to use polystyrene foam insulation beneath and around raceways to reduce frost penetration. These alternatives should also be considered for backfill around the proposed aeration structures.

### General

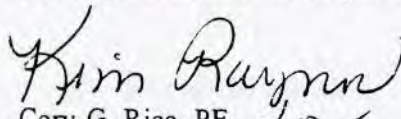
Please refer to the attached report for more detailed results of our field work, engineering analyses and recommendations. The attached report contains lateral earth pressures for design of the raceway walls, aeration walls and canopy foundations. Recommendations related to excavation and backfill are also included in the report.

Thank you for using SK Geotechnical. If you have any questions regarding this report, or require our services during the construction phase of this project, please call Greg Staffileno at (406) 652-3930.

Sincerely,



Gregory T. Staffileno, PE  
Principal, Geotechnical Engineer



Cory G. Rice, PE  
Senior Engineer

gts/cgr:chr

Attachment:  
Geotechnical Evaluation Report

c: Bill Hanson, AIA  
Taylor Architects

John Schlegelmelch, PE  
MT Structural Consultants

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## **A. Introduction**

### **A.1. Project**

The Montana Department of Fish, Wildlife and Parks is planning major improvements at their Bluewater Springs Hatchery. The Bluewater Springs Hatchery is located about 8 miles east of Bridger, Montana.

### **A.2. Purpose of this Evaluation**

The purpose of the geotechnical evaluation was to assist Robert Peccia & Associates (RPA), project civil engineers, MT Structural Consultants, project structural engineers, and Taylor Architects, in designing foundations and slabs, and in preparing plans and specifications for the proposed hatchery improvements.

### **A.3. Scope**

The desired scope of services was outlined in a July 7, 1999, request-for-proposal letter from Ms. Nancy Granger Cormier, PE, of RPA. On July 15, we submitted a proposal to Ms. Cormier for the geotechnical evaluation. Mr. Keith Jensen, president of RPA, authorized us to proceed in accordance with the proposal on July 22, 1999.

Our scope of services was limited to:

- reconnaissance of the site by a geotechnical engineer,
- staking the boring locations and determining ground surface elevations at the boring locations,
- coordinating the locating of underground utilities near the boring locations,
- conducting 12 penetration test borings to a depth of 15 feet in the proposed building and structure areas,
- performing two hand auger borings near Bluewater Spring to depths ranging from 5 to 10 feet,
- taking eight thin-walled tube samples to provide relatively undisturbed samples for consolidation tests,
- collecting five bag samples of subgrade soils for various laboratory tests,

- returning the samples to our laboratory for visual classification and logging by a geotechnical engineer,
- conducting the following laboratory tests:
  - three consolidation/swell tests on thin-walled tube samples,
  - three standard Proctors,
  - three classification (Atterberg limits and sieve analysis), and
  - three corrosion tests,
- analyzing the results and formulating recommendations for earthwork, spread footing foundations and slabs,
- analyzing the results and discussing the project with Ms. Cormier and Mr. John Schlegelmelch, PE, structural engineer of MT Structural Consultants, and
- submitting a geotechnical evaluation report containing logs of the borings, our analysis of the field and laboratory tests, and recommendations for earthwork, foundations, slabs and other structural components of the project.

#### **A.4. Documents Provided**

RPA provided the following documents for our use:

- Figure 2-2, Existing Hatchery Site Plan, and
- Figure 4-1, Proposed Site Plan.

The desired location for the 12 soil borings were shown on both of these figures.

#### **A.5. Locations and Elevations**

The locations of the borings are shown on Figures 2-2 and 4-1 attached to this report. It is our understanding the 12 soil boring locations were selected by Taylor Architects. The locations of Hand Auger Borings HA-13 and HA-14 were selected by our personnel, and are also shown on the figures. Penetration test borings are designated by the prefix "ST" and hand auger borings by the prefix "HA".

Ground surface elevations at the borings were referenced to Control Point CP 2, CP 4 and CP 8. The locations and elevations of these control points were included on the figures.

## **B. Results**

### **B.1. Logs**

Log of Boring sheets indicating the depths and identifications of the various soil strata, the penetration resistances, laboratory test data and water level information are attached. It should be noted the depths shown as boundaries between the strata are only approximate. The actual changes may be transitions and the depths of the changes vary between borings.

Geologic origins presented for each stratum on the Log of Boring sheets are based on the soil types, blows per foot, and available common knowledge of the depositional history of the site. Because of the complex hydrogeologic, alluvial, and post-glacial depositional environments, geologic origins are frequently difficult to ascertain. A detailed evaluation of the geologic history of the site was not performed as part of the geotechnical evaluation.

### **B.2. Site Conditions**

Bluewater Trout Hatchery is located about 8 miles east of Bridger, Montana. The existing hatchery layout is shown on Figure 2-2 attached to this report. As can be seen, the existing hatchery has numerous existing concrete raceways and buildings. There are also several residences and garages located on the property. Bluewater Spring is located on the east side of the property as shown.

During our reconnaissance, we observed numerous cracks in the existing concrete of the upper raceways. Some of the larger cracks have been patched and differential movement has occurred across them. It is our understanding the upper raceways do not have any reinforcing steel embedded in the concrete. The lower raceways have performed much better. These raceways have an expansion joint in them and were constructed of reinforced concrete. Significant cracks and differential movement have not been observed, although some scaling has occurred in the concrete.

The ground surface at the hatchery is sloping downward towards the west at a slope ranging from 3 to 6 percent. Numerous existing gravel roads currently run across the site and in between the buildings. Much of the property is also covered with lawn. Natural valley grasses are located in and around Bluewater Spring.

### **B.3. Soils**

**B.3.a. General.** The general soil profile encountered at the borings was 3 to 12 inches of organic clay topsoil over alluvial clays and silty sand tufa. Existing fill was encountered in five of the borings to depths ranging from 1/2 to 4 1/2 feet. Tufa is defined as a chemical sedimentary rock composed of calcium carbonate. It is fairly common in spring areas, and is associated with dissolved calcium carbonate in the spring water. The spring water flows through the existing soils and evaporates, leaving calcium carbonate deposits in the soils. With time, the calcium carbonate solidifies and cements the soil.

The geologic origin of the majority of the soils encountered by the shallow borings was alluvium. These alluvial clays and sands are associated with Bluewater Spring and Bluewater Creek. Layers of slightly to partially cemented tufa were encountered within the alluvial deposits.

**B.3.b. Topsoil.** Most of the borings encountered 2 to 5 inches of topsoil and root zone. Boring ST-1, however, encountered 1 foot of organic clay topsoil. Hand Auger Boring HA-14 encountered 0.7-foot of organic clay topsoil. Buried organic clay topsoil was also encountered beneath existing fill in Boring ST-2 from 2 to 2 1/2 feet and Hand Auger Boring HA-13 from 4.4 to 5 feet.

**B.3.c. Existing Fill.** Existing fill consisting of sandy gravel surfacing was encountered in Borings ST-4, ST-10 and ST-12 to depths ranging from 2 to 6 inches. Sandy lean clay fill was encountered in Boring ST-2 to a depth of 2 feet and in Boring HA-13 to 4.4 feet, where it was underlain by the old topsoil. The penetration resistance in the lean clay fill was 10 blows per foot (BPF). The estimated unconfined compressive strengths of the lean clay fill generally ranged from 900 to 2,700 pounds per square foot (psf). These values indicated the lean clay fill was medium to rather stiff.

Existing fill consisting of organic clay was also encountered in Boring ST-6. This boring was performed on the pad prepared for the artisan well. It appears the contractor used the previously stripped topsoil as fill in this area.

**B.3.d. Alluvium.** Sandy lean clay and lean clay alluvium were encountered beneath the existing fill and topsoil in all of the borings to depths ranging from 1 1/2 to 4 feet. Penetration resistances in the surficial alluvial clays ranged from 3 to 16 BPF, but were generally between 6 and 10 BPF. These values indicated the surficial alluvial clays ranged from soft to stiff, but were generally medium to rather stiff in consistency.

In the majority of the borings, tufa was encountered beneath the surficial lean clays to depths ranging from 4 to 7 1/2 feet. Below these depths, the borings encountered lean clay, sandy lean clay and fat clay alluvium. The penetration resistances in the deeper underlying alluvial clays were much lower, and generally ranged from weight-of-hammer (WH) to 8 BPF, but were generally between 1 and 4 BPF. Unconfined compressive strengths in these alluvial clays were generally less than 1,000 psf. These values indicated the underlying alluvial clays were very soft to medium, but were generally of a very soft to soft consistency.

Lean to fat clay alluvium was encountered in Hand Auger Boring HA-13 beneath the buried topsoil below a depth of 5 feet. This hand auger boring was within about 6 feet of the spring and on the north side. The underlying alluvial clays were wet/waterbearing, and unconfined compressive strengths were 1,000 to 1,500 psf. These values indicated the lean to fat clay encountered in this boring was of a medium consistency. In Hand Auger Boring HA-14, lean to fat clay was encountered beneath the clay topsoil to a depth of 5 feet. This boring was performed on the northwest side of Bluewater Spring, and the clays did not appear to be as saturated. Unconfined compressive strengths in these clays ranged from 1,800 to 4,700 psf, indicating they were rather stiff to very stiff. A layer of clayey sand alluvium was encountered in HA-14 from 3 1/2 to 4 feet. The clayey sand was waterbearing.

**B.3.e. Tufa.** Tufa consisting of silty sand was encountered in Borings ST-3 through ST-12. It was not encountered in Borings ST-1 and ST-2, and Hand Auger Borings HA-13 and HA-14 performed around Bluewater Spring. As can be seen on the logs, the tufa layer was generally sandwiched between the alluvial clay from about 2 1/2 to 7 1/2 feet. In the hatchery building area, the penetration resistances encountered in the tufa layers generally ranged from 2 to 7 BPF, indicating the silty sand was very loose to loose. In the proposed raceway areas, the tufa was more cemented and penetration resistances ranged from 6 to 37 BPF. In Borings ST-10 and ST-12, more cemented tufa layers with penetration resistances of 50 blows for 5 inches of penetration were recorded. In the raceway areas, the penetration resistances indicated the tufa was generally loose to medium dense, with the more cemented layers being very dense.

#### **B.4. Groundwater Observations**

Groundwater was observed in 11 of the 14 borings at the depths and elevations indicated in Table 1 below.

**Table 1. Depths and Elevations to Groundwater**

Boring	Surface Elevation	Depth to Groundwater, feet*	Corresponding Elevation*	Comments
ST-1	102.0	10	92	---
ST-2	94.0	3	91	Water level ~spring level.
ST-3	88.8	6 1/2	82 1/2	---
ST-4	81.4	8	73 1/2	Perched Groundwater
ST-5	76.9	NE**	---	---
ST-6	76.6	12 1/2	64	---
ST-7	76.2	13	63	---
ST-8	73.7	NE	---	---
ST-9	71.6	15	56 1/2	---
ST-10	70.5	14 1/2	56	---
ST-11	56.4	14 1/2	42	---
ST-12	63.7	NE	---	---
HA-13	94.0	3	91	Water level ~spring level.
HA-14	94.4	3 1/2	91	Water level ~spring level.

\*Depth and elevation of groundwater rounded to nearest 1/2'.

\*\*NE - Groundwater not encountered in boring, but several days may be required for groundwater to enter borehole.

We wish to point out the above groundwater levels can fluctuate with changes in water levels of Bluewater Spring and Bluewater Creek. All of these borings encountered alluvial clays. Several days may be required for groundwater to stabilize in a boring performed in clay soils. Wet/saturated clays were observed in several of the borings below a depth of about 4 to 6 feet. These wet/saturated clays may indicate groundwater levels may be present at higher levels than indicated by the borings and summarized in the above table.

We typically install temporary piezometers to allow monitoring of groundwater levels on sites. Artisan groundwater flows are known to be present in the hatchery area. We were therefore reluctant to install any temporary piezometers (wells) in the soil borings.

## **B.5. Laboratory Tests**

The results of the laboratory tests are presented on the boring logs, Atterberg limits figure, sieve analysis sheets and consolidation/swell graphs in the Appendix. These results are also discussed in more detail below.

**B.5.a. Pocket Penetrometer Tests.** The clay samples were tested with a pocket penetrometer to estimate their unconfined compressive strengths. A pocket penetrometer consists of a 1/4-inch diameter rod which is pushed 1/4 inch into the clay soil by a spring. Compression of the spring has been correlated with the unconfined compressive strength of clay soils by the manufacturer. The results of the pocket penetrometer tests are presented on the Log of Boring sheets in the Appendix.

**B.5.b. Classification Tests.** Classification tests consisting of Atterberg limits and sieve analysis were conducted on samples from Borings ST-8, ST-9 and ST-12. The samples from ST-8 and ST-12 had liquid limits of 30 and 32, plastic limits of 17 and 18, and plasticity indexes of 12 and 15. The percent-finer-than-a-200-sieve of these samples were 56 and 61 percent. Based on these test results, the samples classify as sandy lean clay. The American Society for Testing and Materials (ASTM) symbol for these soils is CL.

The sample from Boring ST-9 had a liquid limit of 49, plastic limit of 18 and plasticity index of 31. The percent-finer-than-a-200-sieve of this sample was 97 percent. Based on these results, the sample classifies as lean to fat clay, and the ASTM symbol is CL/CH.

**B.5.c. Proctor.** Standard Proctors were performed on three bag samples from the borings in accordance with ASTM Method of Test D 698. The Proctors are attached to this report. The sandy lean clay and lean clay samples had maximum dry densities ranging from 102 to 112 pounds per cubic foot (pcf). The optimum moisture contents ranged from 15 to 16 percent. These are typical values for lean clay.

**B.5.d. Corrosion Tests.** Three samples were selected for corrosion tests, and the tests were performed in accordance with Montana Department of Transportation (MDT) procedures. The results of the corrosion tests are summarized in Table 2 below.

**Table 2. Summary of Corrosion Tests**

Boring	Sample Depth	pH	Marple pH	Conductivity	Sulfate
ST-8	1' to 5'	7.5	7.5	0.9 mmhos-cm <sup>3</sup>	0.64%
ST-9	8' to 9'	7.7	7.7	1.5 mmhos-cm <sup>3</sup>	0.17%
ST-12	1' to 5'	7.7	7.6	1.0 mmhos-cm <sup>3</sup>	0.56%

These values indicate the site soils are corrosive to buried steel conduits and structures, and are also detrimental to reinforced concrete.

**B.5.e. Consolidation/Swell Tests.** The results of the consolidation/swell tests performed on the thin-walled tube samples from Borings ST-9, ST-12 and HA-13 are attached. The lean clay sample from Boring ST-9 swelled less than 1/2 percent when it was inundated under a load of about 250 psf. This is a very low amount. The lean clay sample from Boring ST-12 collapsed about 1 percent when it was inundated under a load of about 500 psf. This is a relatively low value. Compression of these samples under a load increase of 1,500 psf was about 2 1/2 to 5 percent. These values are considered moderate to relatively high values.

The initial moisture contents of these samples were 22 and 25 percent, indicating they were wet. The initial dry densities were 70 and 86 pcf. These would be considered relatively low dry densities for alluvial clays.

A consolidation test was also performed on the lean clay fill sample from Boring HA-13. The sample consolidated about 7 percent under a load increase of 1,500 psf. This is a very high value. The initial dry density was 64 pcf, which is an extremely low value for lean clay and indicated the material was not compacted when placed. The initial moisture content was 55 percent, which is an unusually high value and indicated the lean clay was saturated/waterbearing.

## **C. Proposed Hatchery Building**

### **C.1. Proposed Construction**

The proposed hatchery building will be a one story metal building with steel framing. The plan dimensions of the proposed hatchery building are 53 feet by 132 feet. The building will have an earth-supported floor slab at elevation 70.0 on the project datum. Existing grades in the hatchery

building generally range from about elevation 74 to 77, therefore, 4 to 7 feet of cut will be required in the hatchery building area.

The building will be supported by perimeter columns. Foundation walls with footings will span between the perimeter columns. Mr. Schlegelmelch indicated the maximum anticipated column loads was 30 kips and the maximum anticipated wall load was 1 kip per foot. He also indicated the distributed load on the wall footings would be less than 1,000 psf.

## **C.2. Discussion**

Borings ST-5 through ST-8 were performed in the hatchery building area. Based on a floor elevation of 70, we anticipate the resulting subgrade will be loose silty sand tufa and very soft lean clay alluvium. The footing trenches will actually extend approximately 4 feet below the floor slab and encounter similar soils, although the clays will likely be even softer.

The borings indicate bearing capacities in the loose silty sand tufa and soft alluvial clays are relatively low, and generally range from about 500 to 1,000 psf. To increase bearing capacities and reduce potential settlement, we recommend subexcavating a minimum of 2 feet beneath the proposed column footings, then replacing the soft clays with compacted structural backfill. It is our opinion the wall footings spanning between the columns can be supported directly on the soft clays. These recommendations are discussed in more detail below.

## **C.3. Foundations**

**C.3.a. Depth.** We recommend footings bear a minimum of 4 feet below exterior grades for frost protection. Interior column footings, if any, can be placed directly beneath the floor slab, provided they bear on structural backfill as described below.

**C.3.b. Footing Subgrade and Subexcavation.** Beneath the proposed column footings, we recommend subexcavating a minimum of 2 feet beneath the proposed footings and at least 1 foot (horizontal) beyond the footing edges. The resulting subgrade will be very soft clays. To provide a suitable working platform and to assist in compacting the structural backfill, we recommend placing a geotextile fabric directly on the soft clays before placing the gravel backfill. We recommend extending the fabric up the subexcavation sidewalls to bottom-of-footing level.

We then recommend placing structural backfill directly on top of the geotextile up to bottom-of-footing level. Structural backfill should consist of 3-inch minus sandy gravel. We recommend the sandy gravel be placed in one lift and at a moisture content near optimum. The underlying geotextile

will prevent the gravels from pushing down into the soft clays and assist in achieving the required compaction. We have found 3-inch minus sandy gravel is the best material for backfilling over such soft clays. Crushed gravel road base can be considered, however, it is more difficult to compact. We recommend the 3-inch minus sandy gravel be compacted to a minimum of 95 percent of its maximum dry density determined in accordance with ASTM Method of Test D 698 (standard Proctor).

As indicated above, the wall footings spanning between the column footings are relatively lightly loaded, and the anticipated distributed load at the footings is only 1,000 psf. For this reason, it is our opinion the wall footings can be supported directly on the soft clays.

To help avoid excessively disturbing the soft clays, we recommend the footing trenches and subexcavation be performed with a backhoe working from the surface. A smooth bucket (without teeth) should be used to excavate the footing trenches and to perform the subexcavations beneath the column footings. This method of excavation is also suggested for the entire building pad to avoid disturbing the subgrade beneath the proposed floor.

**C.3.c. Bearing Pressure.** After necessary subgrade improvements, it is our opinion the column footings can be designed for a net allowable bearing pressure up to 1,500 psf (fifteen hundred pounds per square foot). (Net allowable bearing pressure is defined as that bearing pressure in excess of the final minimum overburden pressure.) This bearing pressure includes a factor of safety of at least three against bearing capacity failure.

**C.3.d. Anticipated Settlement and Heave.** We anticipate total and differential settlement and heave of foundations designed and placed as recommended above will be less than 3/4 inch under the assumed loads. Buildings of this type can generally tolerate movements of this magnitude. We wish to point out, however, some small cracks may occur in the foundation walls.

**C.3.e. Reinforcement.** We recommend sufficient reinforcing steel be placed in the foundation walls to span the loss of support under a footing over a zone 15 feet long at any point along the wall (grade beam action) or loss of support over a zone 10 feet long at a corner (cantilever action). This should reduce the widths of cracks created by shrinkage of the concrete, and local settlement and heave of the soils.

**C.3.f. Foundation Wall Backfill.** We recommend backfill placed on the exterior sides of the foundation walls be compacted to a minimum of 95 percent of its standard Proctor maximum dry density beneath slabs and pavements, and to a minimum of 90 percent in landscaped areas. Soils from the footing excavations may be used, except where frost protection beneath exterior slabs is

desired as discussed later in this report. We recommend clay soils be placed at a moisture content near or slightly above optimum. The levels of the exterior and interior backfills should not differ by more than 8 inches during placement or the walls should be braced, otherwise the foundation walls may be displaced.

**C.3.g. Seismic Considerations.** It is our understanding that Bluewater Hatchery is located near the border of Seismic Zones 2B and 1. It is likely buildings in this area will be designed for Seismic Zone 2B.

We recommend using a soil profile type of  $S_E$  for structural design. Type  $S_E$  is used for soil profiles having 10 feet or more of soft clays as encountered by the borings.

#### **C.4. Earth-Supported Hatchery Building Floor**

**C.4.a. Subgrade.** After the 4- to 7-foot cut in the hatchery building area, we anticipate the resulting subgrade will be very loose silty sands and soft alluvial clays. We recommend the excavation be performed with light-tracked equipment to avoid excessively disturbing the resulting subgrade. The existing organic clay fill encountered in Boring ST-6 will likely be removed during the pad excavation. If not, we recommend all existing fill be removed from beneath the proposed floor and be replaced with compacted backfill.

**C.4.b. Fill and Backfill.** We recommend providing a minimum of 6 inches of crushed gravel road base directly beneath the floor. The thickness of the crushed road base can be increased depending on the desired subgrade modulus. We recommend all fill and backfill beneath the proposed floor slab and in footing and mechanical trenches be moistened to a moisture content near or slightly above optimum moisture content. The fill and backfill beneath the proposed floor slab should be compacted to a minimum of 95 percent of its standard Proctor maximum dry density.

**C.4.c. Vapor Retarder.** If floor coverings or coatings less permeable than the concrete slab will be used, or if moisture is a concern, we recommend a vapor retarder be placed directly beneath the slab. (Some coverings, coatings or situations may require a vapor *barrier*, i.e., a membrane with a permeance less than 0.3 perms.)

**C.4.d. Subgrade Modulus.** If the slab is placed directly on 6 inches of crushed gravel road base, it is our opinion a modulus of subgrade reaction,  $k$ , of 110 pounds per square inch per inch of deflection (pci) may be used to design the floor. If a minimum of 12 inches of compacted crushed gravel road

base is provided beneath the floor, it is our opinion a modulus of 145 pci may be used to design the floor.

## **D. Spring Canopy**

### **D.1. Proposed Construction**

As part of the hatchery improvements, a new canopy will be constructed over the top of the existing Bluewater Spring. As can be seen on the figures, the foundations for the canopy will be laid out in a rectangular shape having plan dimensions of approximately 90 feet by 105 feet. The canopy will be arch-shaped and a crane will be used to place portions of the canopy on the perimeter foundations. The crane will likely be located in the vicinity of Boring ST-1.

The total dead and live loads of the canopy will be approximately 200 kips. It is anticipated this will result in a wall load of approximately 2 kips per linear foot. The canopy will also be subjected to lateral and uplift loads. The lateral and uplift loads may govern the design of the perimeter footings. The perimeter footing will consist of a foundation wall with a footing buried at frost depth.

The ground surface elevation of Boring ST-1 on the south side of the canopy was 102. The ground surface on the north side of the canopy in the vicinity of Hand Auger Boring HA-13 was 94. Therefore, approximately 8 feet of drop occurs from the south side to the north side of the spring area. The top of the foundation wall will likely be about 1 foot above existing grades and the end foundation wall footings will step down to provide adequate frost protection across the sloping site.

### **D.2. Discussion**

Borings ST-1, ST-2, HA-13 and HA-14 were performed in the proposed canopy area. The general soil profile encountered in these borings was up to 1 foot of organic clay topsoil underlain by alluvial clays. In Borings ST-2 and HA-13, the topsoil was underlain by existing sandy lean clay fill to depths of 2 and 4 1/2 feet, respectively. At these depths, a buried layer of organic clay topsoil was encountered.

The borings indicate the footing subgrade on the south and east sides of the canopy will be medium to stiff alluvial clays. It is our opinion these clays will be suitable for direct support of proposed footings. On the north and west sides, however, the existing grades are closer to the level of Bluewater Spring. We anticipate very soft alluvial clays and existing fill underlain by buried topsoil will be encountered at footing subgrade levels in these areas.

To provide a suitable footing subgrade during construction and to assist in dewatering, we recommend subexcavating all of the existing fill and a portion of the soft clays from below the bottoms of proposed footings, and replacing these soils with structural backfill. Our recommendations regarding the canopy footings are discussed in more detail below.

### **D.3. Foundations**

**D.3.a. Depth.** We recommend footings bear a minimum of 4 feet below exterior grades for frost protection. Additional depth may be necessary for resistance to uplift and lateral loads.

**D.3.b. Footing Subgrade and Subexcavation.** On the north and west sides of the proposed canopy area, very soft alluvial clays and existing fill will be encountered at bottom-of-footing level. The actual extent of the very soft clays and existing fill will be determined during construction, although it appears the entire north footing wall and about 70 feet of the west footing wall will encounter these soils.

We recommend subexcavating all of the existing fill beneath these proposed footings and within an oversize zone extending 1/2 foot horizontal for 1 foot of vertical subexcavation beyond the footing edges. Where soft clays are encountered, we recommend subexcavating the soft clays to a depth of 2 feet beneath footings and 1 foot horizontal beyond the footing edges. Groundwater will likely enter the footing trenches and subexcavations, and dewatering should be anticipated. After the soils have been subexcavated, we recommend placing a woven geotextile fabric directly on the soft clay subgrade and up the trench sidewalls 2 feet. We recommend using structural backfill (3-inch minus sandy gravel) in the footing trenches over the geotextile. The sandy gravel should be placed at a moisture content near optimum and in one lift. We recommend the backfill be compacted to a minimum of 95 percent of its standard Proctor maximum dry density.

Extreme care will have to be taken by the contractor during dewatering of these footing trenches and subexcavations. Due to known artisan conditions, dewatering wells should not be used. Shallow dewatering systems will be necessary. Sumps and pumps can be placed about 1 foot below bottom-of-excavation level and used to dewater the areas during construction. The contractor could also utilize the sandy gravel in the bottoms of the footing trenches to assist in dewatering after it has been placed.

**D.3.c. Bearing Pressure.** It is our opinion footings for the proposed canopy may be designed for a net allowable bearing pressure up to 1,000 psf (one thousand pounds per square foot). Footing design, however, may be governed by lateral and uplift loads. (Net allowable bearing pressure is defined as

that bearing pressure in excess of the final minimum overburden pressure.) This bearing pressure includes a factor of safety of at least three against bearing capacity failure.

**D.3.d. Anticipated Settlement and Heave.** We anticipate total and differential settlement and heave of foundations designed and placed as recommended above will be less than 3/4 inch under the given loads. We anticipate the canopy will be able to tolerate movements of this magnitude, but we recommend the canopy manufacturer be consulted for confirmation.

**D.3.e. Reinforcement.** We recommend sufficient reinforcing steel be placed in the foundation walls to span the loss of support under a footing over a zone 15 feet long at any point along the wall (grade beam action) or loss of support over a zone 10 feet long at a corner (cantilever action). This should reduce the widths of cracks created by shrinkage of the concrete, and local settlement and heave of the soils.

**D.3.f. Foundation Wall Backfill.** We recommend backfill placed on the exterior sides of the foundation walls be compacted to a minimum of 95 percent of its standard Proctor maximum dry density. Soils from the footing excavations may be used. We recommend clay soils be placed at a moisture content near or slightly above optimum. The levels of the exterior and interior backfills should not differ by more than 8 inches during placement or the walls should be braced, otherwise the foundation walls may be displaced.

**D.3.g. Uplift Resistance.** For spread footings with compacted backfill placed above them, we recommend assuming the resistance to uplift is equal to the weight of the concrete in the foundation and footing plus the weight of the wedge of soil above the footing. This wedge is formed by planes extending upward and outward from the top edges of the footing at an angle of 30 degrees from vertical for clay backfill. We anticipate the water level could rise to the top of the backfill and we recommend using a submerged unit weight of 45 pcf.

For wind uplift loads, which are transient loads, we recommend a minimum factor of safety of 1 1/2 for the ratio between the calculated ultimate uplift resistance and the design uplift load. For sustained uplift loads, we recommend a minimum factor of safety of two.

**D.3.h. Lateral Resistance.** Lateral resistance for the spread footings supporting the canopy will be provided by net passive lateral pressures and friction between the bottom of the footing and the gravel subgrade. We recommend using the following parameters for estimating lateral forces.

Net passive earth pressure: 90 pounds per square foot per foot of depth (psf/ft).

Coefficient of sliding friction: 0.70.

The values indicated above do not include factors of safety. Appropriate factors of safety should be included when designing foundations to resist lateral forces.

#### **D.4. Crane Support**

Boring ST-1 was performed on the south side of Bluewater Spring. The crane used to lift and place the canopy panels will be located in this area. The general soil profile encountered in Boring ST-1 was 1 foot of organic clay topsoil underlain by rather stiff to medium consistent alluvial clays to a depth of 13 1/2 feet. It is our opinion these soils are suitable to support the proposed crane, although this information should be provided to the contractor and crane supplier for confirmation.

We recommend the organic clay be removed from beneath the proposed crane support area. To provide a more stable platform, we recommend placing at least 1 foot of structural backfill beneath the crane supports. Structural backfill should consist of 3-inch minus sandy gravel, and should be compacted to a minimum of 95 percent.

After placement of the structural backfill, it is our opinion a net allowable bearing capacity of 3,000 psf is available to support the proposed crane. This bearing capacity includes a factor of safety of at least three against bearing capacity failure. We also recommend the crane be kept at least 25 feet (horizontal) away from the edge of the south spring bank.

### **E. Raceways and Aeration Structures**

#### **E.1. Proposed Construction**

**E.1.a. Raceways.** The locations of the first and second pass raceways are shown on Figure 4-1 attached to this report. Borings ST-9 and ST-10 were performed in the first pass raceway, and Borings ST-11 and ST-12 were performed in the second pass raceway. As can be seen on Figure 2-2, the construction of the new raceways will require the demolition and removal of the existing shop building. The proposed raceways will be constructed of cast-in-place concrete. They will have plan dimensions of approximately 70 feet by 115 feet. Raceway divider walls will be spaced approximately every 7 to 8 feet. The average depth of water in the raceways will be approximately 3 1/2 feet, but the foundation walls are provided with freeboard to extend above the water level depth.

In the first pass raceway, the anticipated water level elevation is 71.0. The top of the concrete pad will therefore be approximately elevation 67.5. Assuming a reinforced slab thickness of approximately 12 inches, the bottom-of-pad and footing level will therefore be at elevation 66.5 on the project datum.

At the second pass raceway, the water surface elevation is 60.0. The top-of-base-slab elevation will therefore be about 56.5 and the bottom will be at 55.5.

The slabs in the bottoms of the raceways are imbedded approximately 3 feet below adjacent ground surfaces. It is our understanding that, during use, it is likely some of the raceways will have flowing water while others will not.

**E.1.b. Aeration Structures.** Two aeration structures are planned in the proposed hatchery improvements. The upper aeration structure will likely be located near Boring ST-4, and it has plan dimensions of 7 feet by 25 feet. The lower aeration structure will be located near the first pass raceway, and has plan dimensions of 5 feet by 10 feet. The aeration structures will have concrete slabs that basically act as mat foundations supporting the weight of the structure and water in it. The aeration structures will be buried approximately 6 feet. The upper structure has a water depth of approximately 8 feet and the lower structure a water depth of 6 1/2 feet.

We have assumed the distributed loads on the mat foundations will be less than 1,000 pounds per square foot (psf). We recommend the actual loads in each aeration structure be determined to confirm the distributed loads are 1,000 psf or less. If they exceed 1,000 psf, we should be informed. Additional analysis and recommendations may be necessary.

## **E.2. Discussion**

The borings indicate the subgrade in the raceway areas will be lean clay alluvium and silty sand tufa. More cemented silty sand tufa may be encountered in the bottom of the raceway excavation in the vicinity of Boring ST-12. Similar subgrade soils will likely be encountered for the proposed lower aeration structure. Boring ST-4 indicates soft lean clay could be encountered at the subgrade for the upper aeration structure.

It is our opinion these soils are suitable to support the proposed raceways and aeration structures. The lean clay and silty sand are considered moderately to highly frost-susceptible soils. If these soils get wet and freeze, several inches of frost heave could occur during the winter if no water is running through the raceways for extended periods. This frost heave could cause cracking and leaking of the proposed raceways, which appears to have occurred in the existing upper raceways.

Frost is also a concern for the proposed aeration structures. With the anticipated embedment depths, however, the concern of frost heave is more related to the exterior foundation walls of the aeration structures. If frost penetrates down alongside the walls, excessive lateral forces could push the walls inward, causing them to crack.

To evaluate the effects of frost on the raceways and aeration structures, we have performed a frost analysis. Our recommendations related to design and construction of the raceways and aeration structures are discussed in more detail below.

### **E.3. Subgrade**

As indicated above, we anticipate medium to rather soft clays and loose silty sands will be encountered at slab and mat foundation subgrade elevations for the proposed raceways and aeration structures. It is our opinion these soils are suitable to support the proposed structures.

Boring ST-4 indicated perched groundwater was observed at a depth of about 7 1/2 feet. It is possible a perched water level may be encountered during excavation for the upper aeration structure, and dewatering may be required. If groundwater is encountered, it will likely be necessary to subexcavate about 1 foot below the mat foundation and replace these soils with structural backfill. The structural backfill will provide a suitable working platform during construction. We recommend using 3-inch minus sandy gravel as backfill beneath the upper aeration structure, if necessary. As previously recommended for structural backfill, we recommend it be placed on a geotextile for separation and to assist in achieving the required compaction. We recommend the structural backfill be compacted to a minimum of 95 percent of its standard Proctor maximum dry density.

If excessively soft soils are encountered in the raceway areas, some subexcavation and replacement as described above may be required.

### **E.4. Frost Protection**

**E.4.a. Analysis.** To evaluate potential impacts on frost penetrating below and alongside the raceways and aeration structures, we performed frost depth calculations to estimate penetration depths. Our analysis indicated that, in an average year with about 730 cumulative freezing degree days, the frost penetration below the raceway slab will be about 3 feet. Per the design charts, this is an average value for the Billings area, which we feel is also representative of the Bluewater Hatchery area. In a severe winter with about 1,300 cumulative freezing days, we estimate frost penetration will be about 5 feet.

Flowing water would generally prevent slabs and underlying subgrade from freezing. However, if no water is flowing across the raceways, frost will begin to penetrate beneath the raceway slabs. The on-site soils are silty sands and lean clays, and these soils are considered highly frost-susceptible. Ice lenses will likely form in the native soils and cause heaving of the slabs. The raceway base slab and aeration mat foundation as well as their vertical walls will be reinforced concrete, which will provide some beam action. This will help make the movement more uniform.

If water is always flowing through the raceways and aeration structures, it is our opinion no preventative measures need to be installed to reduce the risk of frost heave. On the other hand, if portions of the raceway and aeration structures could be exposed during the winter, we recommend providing one of the two following types of frost protection for the structures.

**E.4.b. Nonfrost-Susceptible Backfill.** Alternative 1 is to provide nonfrost-susceptible backfill to reduce the risk of frost penetrating around and beneath the raceways and aeration structures and causing excessive movement. Our recommendations regarding this alternative are shown on the sketches following this page.

As can be seen, we recommend providing 3 feet of nonfrost-susceptible sand or sandy gravel backfill below the base of the raceway slabs. We also recommend using the nonfrost-susceptible sand or sandy gravel as backfill on the exterior sides of the perimeter raceway walls, and that it be capped with 1 foot of clay and topsoil. Beneath the raceway, drain pipes should be installed within the sand or sandy gravel to prevent seepage accumulation. The drain pipes should be drained by gravity down and away from the raceways.

This alternative can also be utilized for the aeration structures. When considering the depth of the aeration structures (at least 6 feet), it is our opinion it will not be necessary to subexcavate beneath the mat foundations. We recommend the nonfrost-susceptible sand or sandy gravel, however, be used as backfill on the exterior sides of the perimeter aeration walls. These recommendations are shown on the attached sketch.

Sand or sandy gravel with less than 5 percent of its particles by weight passing a 200 sieve is generally considered nonfrost-susceptible. The sand or sandy gravel backfill beneath and around the raceways and aeration structures should be compacted to a minimum of 95 percent of its standard Proctor maximum dry density.

**E.4.c. Insulation.** Alternative 2 to reduce frost penetration is to install foam insulation in and around the structures. The layout of polystyrene foam insulation for the raceways and aeration structures are shown on the sketches following this page.

For the raceways, we recommend providing 5 feet (horizontal) of 2-inch thick polystyrene foam insulation around the perimeter of the raceways. This insulation should be buried beneath 1 foot of clay and topsoil. The foam insulation should then extend down alongside the perimeter foundation walls and beneath the raceway slabs. We recommend providing 4 inches of sand cushion directly beneath the insulation panels. After the panels are placed on the sand, we then recommend providing 6 inches of crushed base course over the panels to protect them during construction and for placement of the concrete slab.

For the aeration structures, we similarly recommend providing 5 feet (horizontal) of foam insulation beneath the clay and topsoil around the perimeter of the aeration structures. Foam insulation should also be provided vertically alongside the perimeter foundation walls to a depth of 2 feet below the anticipated lowest water level surface during the winter.

It is our opinion on-site soils can and should be used as backfill around the structures with this alternative. We recommend the backfill be placed in lifts not exceeding 8 inches uncompacted thickness and at a moisture content near or slightly above optimum moisture content. We recommend the backfill be compacted to a minimum of 95 percent of its standard Proctor maximum dry density.

## **E.5. Lateral Earth Pressures**

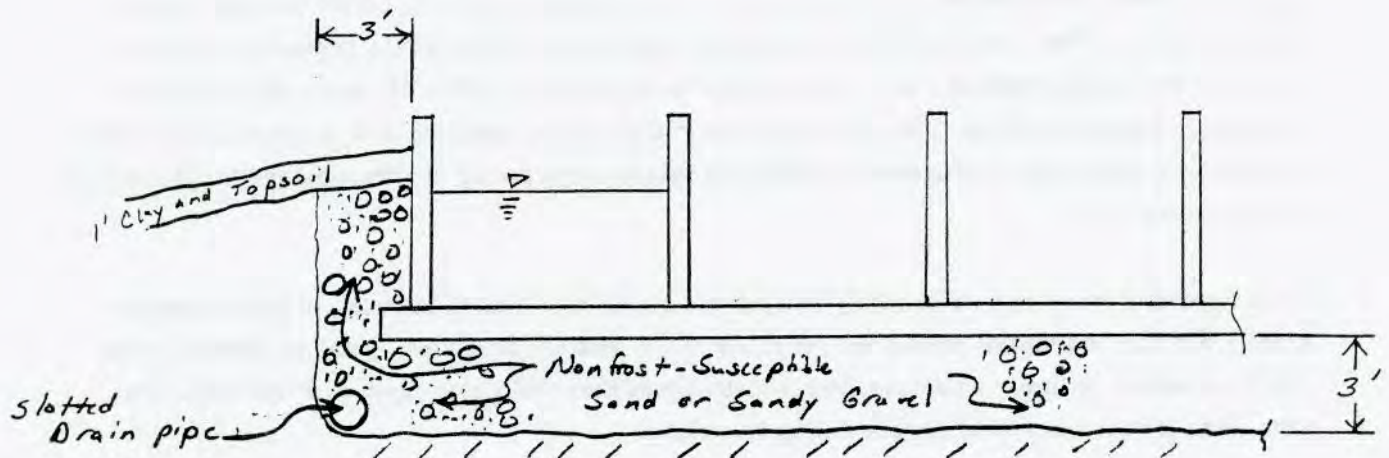
**E.5.a. Nonfrost-Susceptible Backfill.** If nonfrost-susceptible sand or sandy gravel backfill is used around the raceways and aeration structures, we recommend using the following parameters for estimating lateral forces.

- Active earth pressure (wall free to move away from backfill): 37 pounds per square foot per foot of depth (psf/ft).
- At-rest earth pressure (wall restrained): 60 psf/ft.

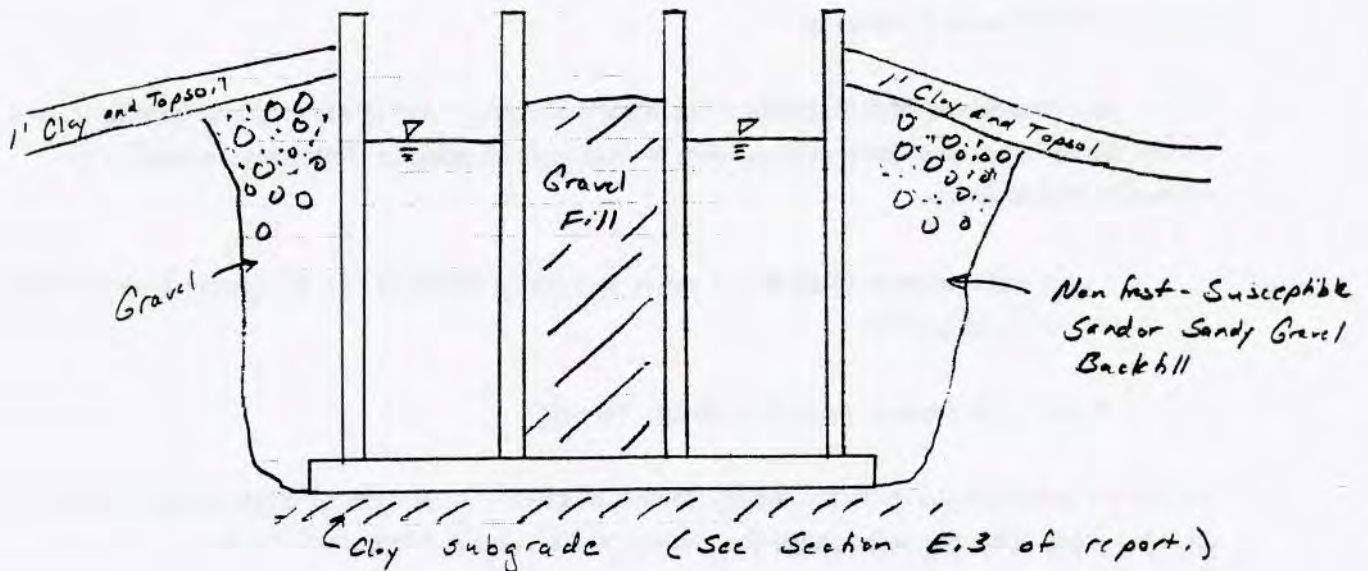
The values indicated above do not include factors of safety. Appropriate factors of safety should be included when designing unbalanced foundations walls to resist lateral earth forces.

Description: Bluewater Hatchery  
E. of Bridger, MT  
 Project No: 991097  
 Date: 8/16/99 By: G. Staffano

## ALTERNATIVE 1. Non frost - Susceptible Materials.



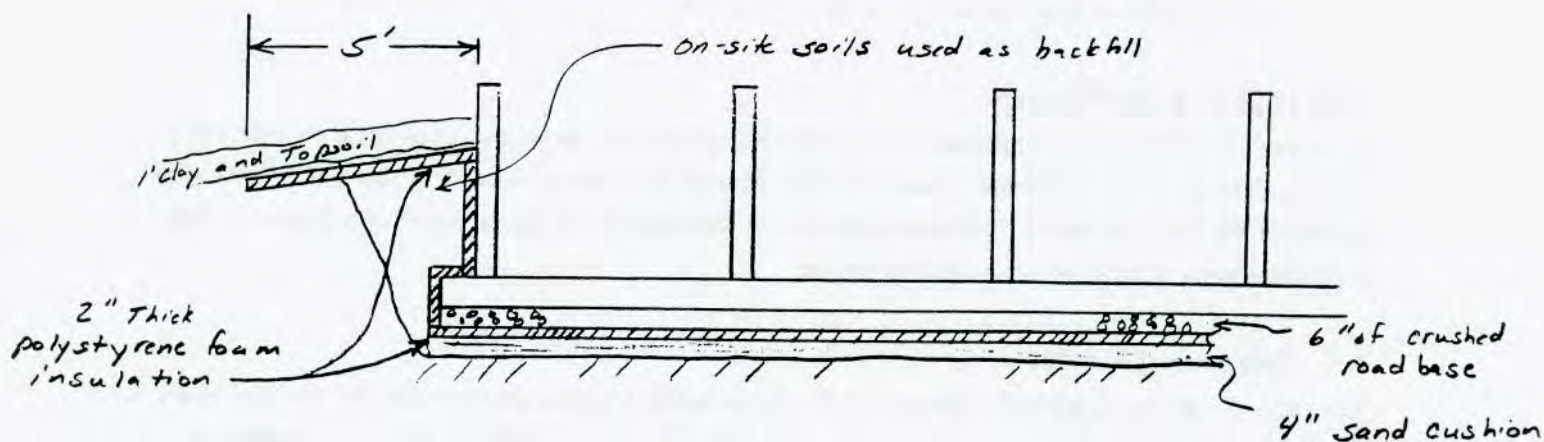
RACEWAY SKETCH (No Scale)



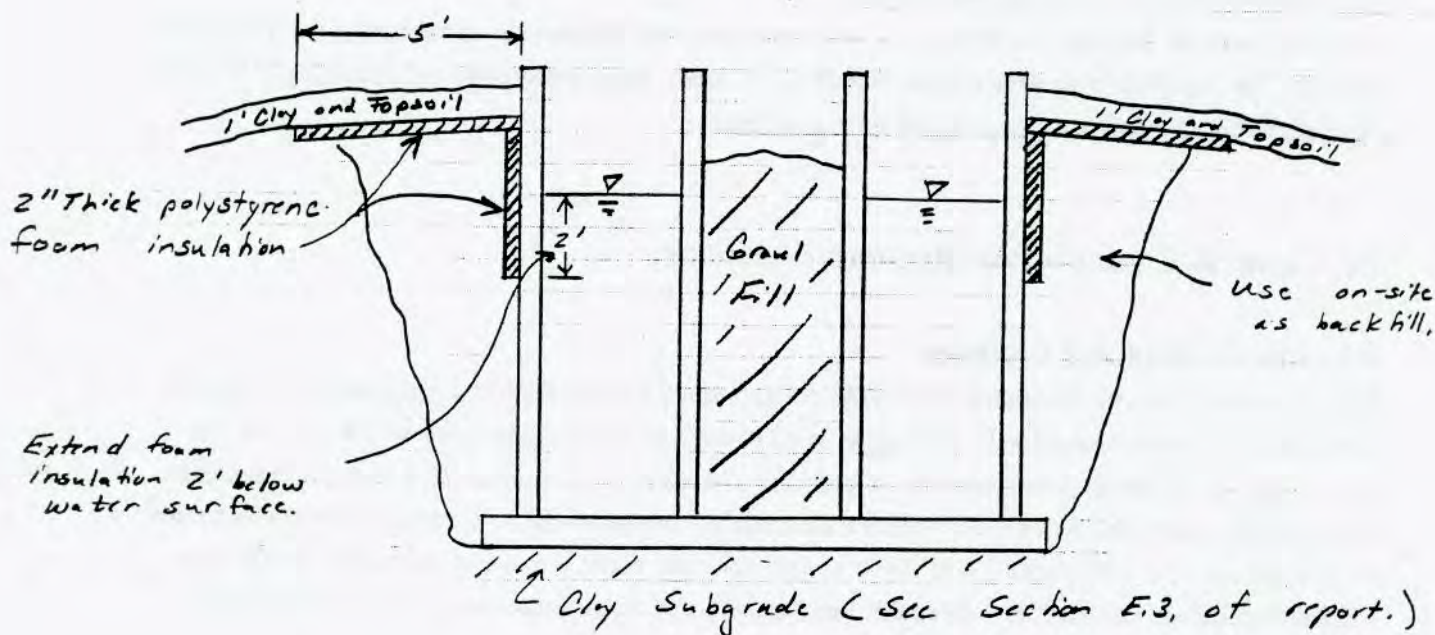
AERATION STRUCTURE SKETCH (No Scale)

Description: Bluewater Hattery  
E. of Bridge, MT  
 Project No: 991097  
 Date: 8/14/99 By: G. Shiffling

## ALTERNATIVE 2. Foam Insulation



## RACEWAY SKETCH (No Scale)



## AERATION STRUCTURE SKETCH (No Scale)

**E.5.b. On-Site Soils.** If the foam insulation panels are used to reduce frost penetration, on-site lean clays and silty sands can be used as backfill. We recommend using the following parameters for estimating lateral forces for on-site soils.

- Active earth pressure (wall free to move away from backfill): 47 psf/ft.
- At-rest earth pressure (wall restrained): 66 psf/ft.

### **E.6. Mat Bearing Pressure**

It is our opinion the mat foundations for the aeration structures can be designed for a net allowable bearing pressure up to 1,000 psf. (Net allowable bearing pressure is defined as that bear pressure in excess of the final minimum overburden pressure.) This bearing pressure includes a factor of safety of at least three against bearing capacity failure.

### **E.7. Subgrade Modulus**

If 3 feet of nonfrost-susceptible sand or sandy gravel backfill is provided beneath the raceway slabs, it is our opinion the slabs can be designed for a subgrade modulus of 250 pci. If foam insulation is used and only 6 inches of crushed road base is provided, it is our opinion that a subgrade modulus of 110 pci should be used to design the raceway slabs.

### **E.8 Anticipated Settlement and Heave**

Assuming average freezing conditions, we anticipate total and differential settlement and heave of the raceways and aeration structures will be less than 1/2 inch. Reinforced concrete structures of this type should be able to tolerate movements of this magnitude.

## **F. General Construction Recommendations**

### **F.1. Site Grading and Drainage**

We recommend the site be graded to provide positive run-off away from the proposed buildings and structures. We recommend landscaped areas have a slope of at least 5 percent for the first 10 feet away from the building, then 2 percent, to carry run-off away. To maintain this slope, it is essential that backfill against the foundation walls be adequately compacted. If it is not adequately compacted, exterior foundation wall backfill will likely consolidate and water may pond and soak into the soil, causing settlement. In addition, we recommend gutters and downspouts with long splash blocks or extensions for the hatchery building.

## **F.2. Utilities**

**F.2.a. Materials.** The corrosion tests indicated the on-site alluvial clays and silty sand tufa are corrosive to metallic conduits. We recommend specifying noncorrosive materials or providing corrosion protection for buried utilities.

**F.2.b. Subgrade.** As previously indicated, the majority of the borings encountered very soft alluvial clays. These alluvial clays were wet and in many cases saturated. We recommend the excavation of utility trenches be performed with a backhoe having a smooth bladed bucket working from the surface. This will help avoid excessive disturbance of the resulting trench subgrade. Even so, it is likely some areas of the trench subgrade will be unsuitable for direct support of buried utilities. In these areas, we recommend subexcavating and replacing the soft subgrades with Type II bedding as specified in accordance with *Montana Public Works Standard Specifications* (MPWSS).

**F.2.c. Trench Backfill and Compaction.** We recommend using Types I and II trench backfill as specified in accordance with MPWSS beneath and around buried utilities. On-site soils from the trench excavations may be used above Type I bedding.

We recommend bedding material be thoroughly compacted around the pipes. We recommend trench backfill above the bedding be compacted to a minimum of 90 percent in landscaped areas and 95 percent beneath proposed footings and slabs. Backfilling around and above utilities should meet the requirements of MPWSS.

## **F.3. Concrete**

Laboratory corrosion tests indicated the on-site clays and silty sands are also detrimental to concrete. We recommend using cement meeting the requirements of ASTM C 150 Type V, Type II plus slag or Type II plus pozzelon to provide moderate resistance to sulfate attack. We recommend specifying 5 to 7 percent entrained air for exposed concrete to provide resistance to freeze-thaw deterioration. We also recommend using a water-cement ratio of 0.45 or less for concrete exposed to deicers.

## **F.4. Excavation**

It is our opinion the soils encountered by the borings can be excavated with a backhoe, front-end loader or scraper. As previously indicated, however, very soft alluvial clays were encountered in the surface and will be encountered in the majority of the structure excavations. To avoid excessively disturbing the footing and slab subgrades, it is recommended the earthwork and excavation be performed with low-pressure tracked equipment. A tracked backhoe working from the surface with a smooth bladed bucket is the preferred excavation equipment.

The borings indicate all soils encountered in excavations over 5 feet deep will be Type C soils under Department of Labor Occupational Safety and Health Administration (OSHA) guidelines. All earthwork and construction should be performed in accordance with OSHA guidelines.

#### **F.5. Observations**

We recommend footing and structure subgrades be observed by a geotechnical engineer or an engineering technician working under the direction of a geotechnical engineer to see if the subgrade soils are similar to those encountered by the borings. The removal of existing fill and subexcavations from beneath proposed footings and slabs should also be observed.

During excavation for footings, we recommend tests be conducted on structure subgrades to evaluate if the bearing capacity is at least 1,000 or 1,500 psf, depending on the specific structure. Typical instruments used for these tests include hand augers, penetrometers and sample tubes.

#### **F.6. Moisture Conditioning**

Site soils which will be excavated and reused as backfills and fills appeared to be wet and are likely over the soils' optimum moisture content. It will likely be necessary to spread these soils out and allow them to dry in order to achieve a moisture content near or slightly above optimum.

It should also be anticipated that imported fill and backfill materials will be below optimum moisture content and additional moisture will be necessary to achieve a moisture content near or slightly above optimum.

#### **F.7. Subgrade Disturbance**

The borings indicate the surficial subgrade will be lean clay. These fine-grained soils are considered to be moisture sensitive and are easily disturbed when wet. We therefore recommend good drainage of surface water be provided during construction to help avoid ponding areas. Ponding water will result in saturation of the lean clay soils, creating soft spots. Construction traffic driving across these soft spots can create large ruts and excessively disturb the areas. It is then very difficult to recompact these areas to specification and they can result in construction delays.

#### **F.8. Testing**

We recommend density tests of fills and backfills placed beneath footings and slabs. Density tests should also be performed on foundation wall backfill. We also recommend density testing of the compacted pavement subgrade and gravel base course. Samples of proposed backfill and fill materials should be submitted to our testing laboratory at least three days prior to placement on the site for

evaluation, and determination of their optimum moisture contents and maximum dry densities. We recommend slump, air content and strength tests on Portland cement concrete.

#### **F.9. Cold Weather Construction**

If site grading and construction is anticipated during cold weather, we recommend good winter construction practices be observed. All snow and ice should be removed from cut and fill areas prior to additional grading. No fill should be placed on soils which have frozen or contain frozen material. No frozen soils should be used as fill.

Concrete delivered to the site should meet the temperature requirements of ASTM C 94. Concrete should not be placed upon frozen soils or soils which contain frozen material. Concrete should be protected from freezing until the necessary strength is attained. Frost should not be permitted to penetrate below footings bearing on frost-susceptible soil since such freezing could heave and crack the footings and/or foundation walls.

### **G. Procedures**

#### **G.1. Drilling and Sampling**

Penetration test Borings ST-1 through ST-12 were performed on July 14 through 19, 1999, with a truck-mounted core and auger drill. Sampling for the borings was conducted in accordance with ASTM D 1586, "Penetration Test and Split-Barrel Sampling of Soils." Using this method, we advanced the borehole with hollow-stem auger to the desired test depth. Then an automatic 140-pound hammer falling 30 inches drove a standard, 2-inch OD, split-barrel sampler a total penetration of 1 1/2 feet below the tip of the hollow-stem auger. The blows for the last foot of penetration were recorded and are an index of soil strength characteristics.

Seven 3-inch diameter thin-walled tube samples were taken in clay soils in general accordance with ASTM D 1587, "Thin-walled Tube Sampling of Soils." The tubes were slowly pushed into undisturbed soils below the hollow-stem auger. After they were withdrawn from the boreholes, the ends of the tubes were sealed and the tubes were carefully transported to our laboratory.

Two of the borings encountered very dense silty sand tufa. When the sampler could not be driven 6 inches with 50 blows of the hammer, the distance the sampler was advanced with 50 blows was recorded. When this situation occurred during the first 6 inches of the drive, it was noted as occurring within the "set".

## **G.2. Hand Auger Borings**

Hand Auger Borings HA-13 and HA-14 were performed on July 14, 1999. The hand auger borings were performed with a 2 1/2-inch diameter hand auger to depths of 5 and 10 feet. As the hand auger borings were advanced, proving ring penetrometer tests were conducted on clay soils to evaluate their unconfined compressive strength. The proving ring penetrometer consists of a 3/4-inch diameter cone which is pushed into the clay soils. As the cone is pushed into the soils, a proving ring measures the force which can be correlated to the unconfined compressive strength. The results of the proving ring penetrometer tests are reported on the logs.

## **G.3. Soil Classification**

The drill crew chief and geotechnical engineer visually and manually classified the soils encountered in the borings in accordance with ASTM D 2488, "Standard Practice for Description and Identification of Soils (Visual-Manual Procedures)." A summary of the ASTM classification system is attached. All samples were then returned to the laboratory for a review of the field classifications by a geotechnical engineer. Representative samples will remain in our office for a period of 60 days to be available for your examination.

## **G.4. Groundwater Observations**

About 10 minutes after taking the final sample in the bottom of a boring, the driller probed through the hollow-stem auger to check for the presence of groundwater. Immediately after withdrawal of the auger, the driller again probed the depth to water or cave-in. The boring was then backfilled.

# **H. General Recommendations**

## **H.1. Basis of Recommendations**

The analyses and recommendations submitted in this report are based upon the data obtained from the soil borings performed at the locations indicated on the attached sketch. Often, variations occur between these borings, the nature and extent of which do not become evident until additional exploration or construction is conducted. A reevaluation of the recommendations in this report should be made after performing on-site observations during construction to note the characteristics of any variations. The variations may result in additional foundation costs, and it is suggested a contingency be provided for this purpose.

It is recommended that we be retained to perform the observation and testing program for the site preparation phase of this project. This will allow correlation of the soil conditions encountered during construction to the soil borings, and will provide continuity of professional responsibility.

## H.2. Review of Design

This report is based on the design of the proposed structures as related to us for preparation of this report. It is recommended that we be retained to review the geotechnical aspects of the designs and specifications. With the review, we will evaluate whether any changes in design have affected the validity of the recommendations, and whether our recommendations have been correctly interpreted and implemented in the design and specifications.

## H.3. Groundwater Fluctuations

We made water level observations in the borings at the times and under the conditions stated on the boring logs. These data were interpreted in the text of this report. The period of observation was relatively short, and fluctuation in the groundwater level may occur due to rainfall, flooding, irrigation, spring thaw, drainage, and other seasonal and annual factors not evident at the time the observations were made. Design drawings and specifications and construction planning should recognize the possibility of fluctuations.

## H.4. Use of Report

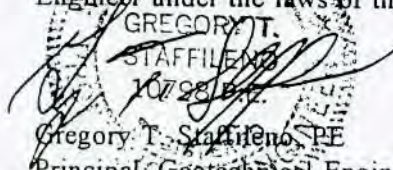
This report is for the exclusive use of Robert Peccia & Associates, Taylor Architects and MT Structural Consultants to use to design the proposed structures and prepare construction documents. In the absence of our written approval, we make no representation and assume no responsibility to other parties regarding this report. The data, analyses and recommendations may not be appropriate for other structures or purposes. We recommend parties contemplating other structures or purposes contact us.

## H.5. Level of Care

Services performed by SK Geotechnical Corporation personnel for this project have been conducted with that level of care and skill ordinarily exercised by members of the profession currently practicing in this area under similar budget and time restraints. No warranty, expressed or implied, is made.

### Professional Certification

I hereby certify that this report was prepared by me and that I am a duly Licensed Professional Engineer under the laws of the State of Montana.

  
Gregory T. Staffileno, PE  
Principal, Geotechnical Engineer  
License Number 10798PE  
August 17, 1999

## **Appendix**



Site Location Sketch

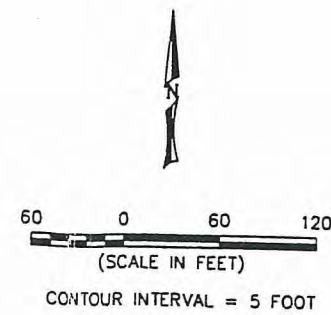
**SK**  
**Geotechnical**  
**Corporation**

Geotechnical Evaluation  
 Bluewater Springs Hatchery Improvements  
 East of Bridger, Montana

139

INT	DATE	SHEET
DRAWN BY: USGS		
APP'D BY:		OF
JOB No. 991097		
DWG.No.	FIGURE#	
SCALE 1" = 2,000'		

LEGEND			
BUILDING		FLAG	
BRUSH		GRAVEL ROAD	
CATTLEGUARD		PIPE	
CONIFER TREE		POWER POLE	
CONCRETE STRUCTURE		PROPANE TANK	
CONTROL POINT		TELEPHONE PEDESTAL	
CULVERT		SATELLITE DISH	
DECIDUOUS TREE		OPEN WATER	
FENCE			



BORING LOCATION SKETCH (PROPOSED)  
Geotechnical Evaluation  
Bluewater Spring Hatchery Improvements  
East of Bridger, Montana  
Drawn by: RPA  
Date: ?  
Project 991097  
Scale: 1" = 120'

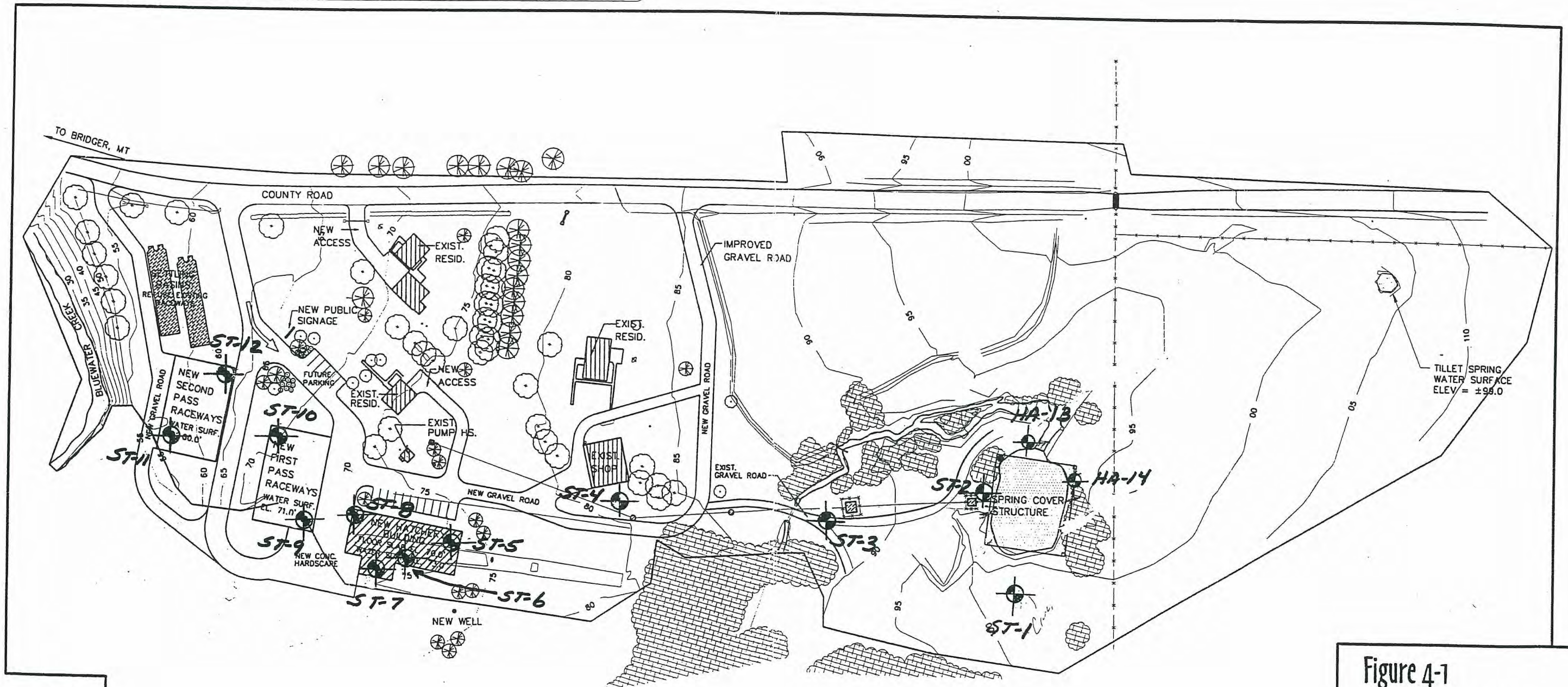


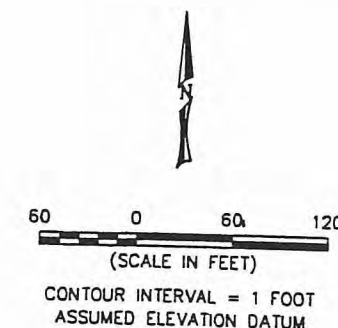
Figure 4-1  
Proposed Site Plan



LEGEND			
BUILDING		FLAG	
BRUSH		GRAVEL ROAD	
CATTLEGUARD		PIPE	
CONIFER TREE		POWER POLE	
CONCRETE STRUCTURE		PROPANE TANK	
CONTROL POINT		TELEPHONE PEDESTAL	
CULVERT		SATELLITE DISH	
DECIDUOUS TREE		OPEN WATER	
FENCE			



BLUEWATER  
TROUT HATCHERY



BORING LOCATION SKETCH (EXISTING)  
Geotechnical Evaluation  
Bluewater Spring Hatchery Improvements  
East of Bridger, Montana  
Drawn by: RPA  
Date: ?  
Project 991097  
Scale: 1" = 120'

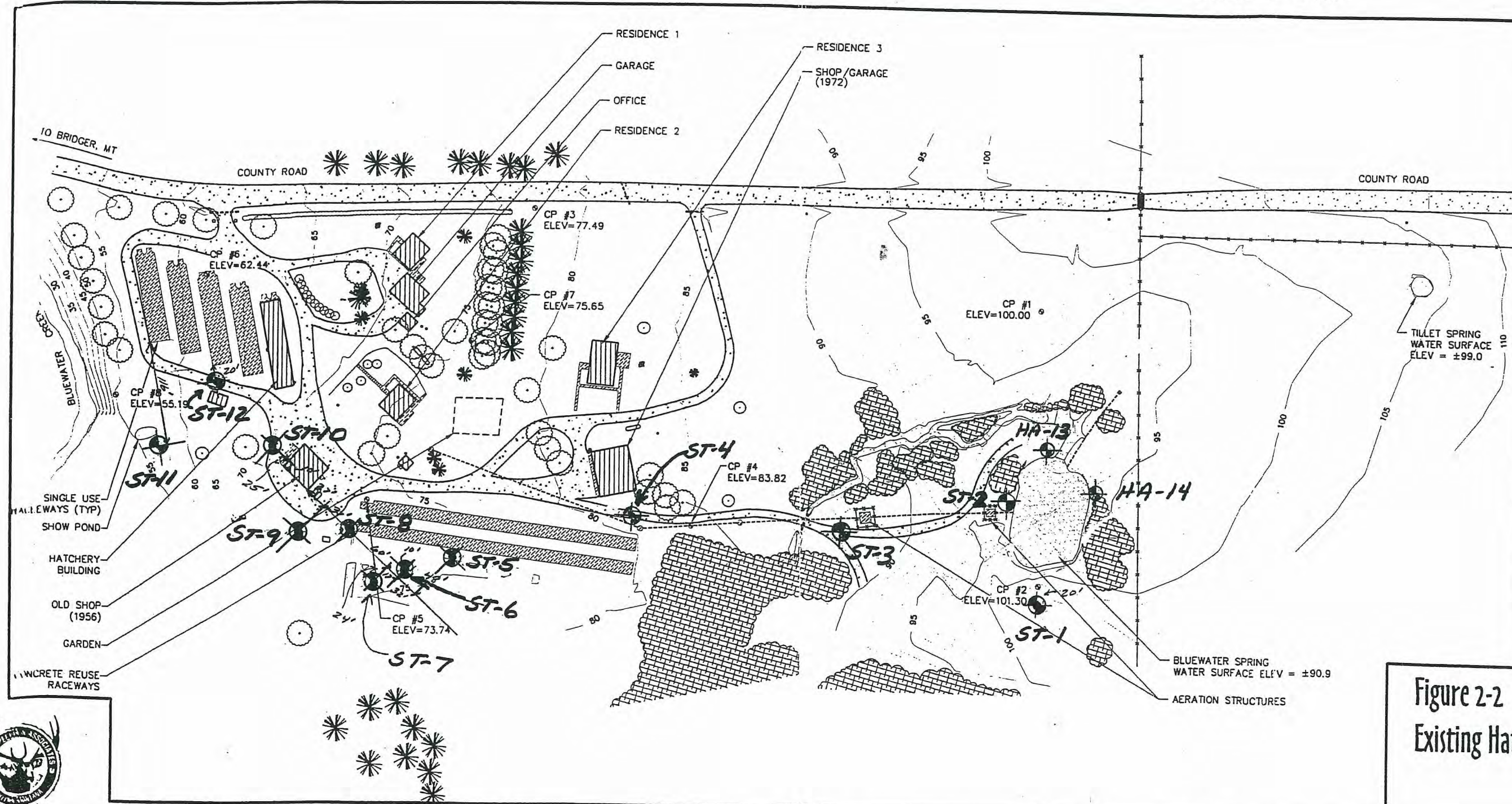


Figure 2-2  
Existing Hatchery Site Plan





## Standard D 2487 - 93 Classification of Soils for Engineering Purposes (Unified Soil Classification System)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests <sup>a</sup>				Soil Classification	
				Group Symbol	Group Name <sup>d</sup>
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines <sup>c</sup>	$C_u \geq 4$ and $1 \leq C_c \leq 3^f$	GW	Well-graded gravel <sup>g</sup>
			$C_u < 4$ and/or $1 > C_c > 3^f$	GP	Poorly graded gravel <sup>g</sup>
		Gravels with Fines More than 12% fines <sup>c</sup>	Fines classify as ML or MH	GM	Silty gravel <sup>g,h</sup>
			Fines classify as CL or CH	GC	Clayey gravel <sup>g,h</sup>
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines <sup>c</sup>	$C_u \geq 6$ and $1 \leq C_c \leq 3^f$	SW	Well-graded sand <sup>i</sup>
			$C_u < 6$ and/or $1 > C_c > 3^f$	SP	Poorly graded sand <sup>i</sup>
		Sands with Fines More than 12% fines <sup>c</sup>	Fines classify as ML or MH	SM	Silty sand <sup>g,k,l</sup>
			Fines classify as CL or CH	SC	Clayey sand <sup>g,k,l</sup>
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silt and Clays Liquid limit less than 50	inorganic	PI > 7 and plots on or above "A" line <sup>j</sup>	CL	Lean clay <sup>k,l,m</sup>
			PI < 4 or plots below "A" line <sup>j</sup>	ML	Silt <sup>k,l,m</sup>
		organic	Liquid limit - oven dried < 0.75 Liquid limit - not dried	OL	Organic clay <sup>k,l,m</sup> Organic silt <sup>k,l,m</sup>
	Silt and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat clay <sup>k,l,m</sup>
			PI plots below "A" line	MH	Elastic silt <sup>k,l,m</sup>
		organic	Liquid limit - oven dried < 0.75 Liquid limit - not dried	OH	Organic clay <sup>k,l,m</sup> Organic silt <sup>k,l,m</sup>
Highly Organic Soils		Primarily organic matter, dark in color, and organic odor		PT	Peat

<sup>a</sup>Based on the material passing the 3" (75 mm) sieve.  
<sup>b</sup>If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

<sup>c</sup>Gravels with 5 to 12% fines require dual symbols.

GW-GM well-graded gravel with silt

GP-GM poorly graded gravel with silt

GW-GC well-graded gravel with clay

GP-GC poorly graded gravel with clay

<sup>d</sup>Sands with 5 to 12% fines require dual symbols.

SW-SM well-graded sand with silt

SP-SM poorly graded sand with silt

SW-SC well-graded sand with clay

SP-SC poorly graded sand with clay

$C_u = D_{60}/D_{10}$   $C_c = (D_{30})^2 / (D_{10} \times D_{60})$

<sup>e</sup>If soil contains  $\geq 15\%$  sand, add "with sand" to group name.

<sup>f</sup>If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.

<sup>g</sup>If fines are organic, add "with organic fines" to group name.

<sup>h</sup>If soil contains  $\geq 15\%$  gravel, add "with gravel" to group name.

<sup>i</sup>If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.

<sup>j</sup>If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

<sup>k</sup>If soil contains  $\geq 30\%$  plus No. 200, predominantly sand, add "sandy" to group name.

<sup>l</sup>If soil contains  $\geq 30\%$  plus No. 200, predominantly gravel, add "gravelly" to group name.

<sup>m</sup> $PI \leq 4$  and plots on or above "A" line.

<sup>n</sup> $PI < 4$  or plots below "A" line.

<sup>o</sup> $PI$  plots on or above "A" line.

<sup>p</sup> $PI$  plots below "A" line.

### Particle Size Identification

Boulders	over 12"
Cobbles	3" to 12"
Gravel	
Coarse	3/4" to 3"
Fine	No. 4 to 3/4"
Sand	
Coarse	No. 4 to No. 10
Medium	No. 10 to No. 40
Fine	No. 40 to No. 200
Silt	No. 200 to .005 mm
Clay	less than .005 mm

### Relative Density of Cohesionless Soils

very loose	0 to 4 BPF
loose	5 to 10 BPF
medium dense	11 to 30 BPF
dense	31 to 50 BPF
very dense	over 50 BPF

### Consistency of Cohesive Soils

very soft	0 to 1 BPF
soft	2 to 3 BPF
rather soft	4 to 5 BPF
medium	6 to 8 BPF
rather stiff	9 to 12 BPF
stiff	13 to 16 BPF
very stiff	17 to 30 BPF
hard	over 30 BPF

### Drilling Notes

Standard penetration test borings were advanced by 3/4" or 6 1/4" ID hollow-stem augers, unless noted otherwise. Jetting water was used to clean out auger prior to sampling only where indicated on logs. Standard penetration test borings are designated by the prefix "ST" (split tube).

Power auger borings were advanced by 4" or 6" diameter continuous flight, solid-stem augers. Soil classifications and strata depths were inferred from disturbed samples augered to the surface and are, therefore, somewhat approximate. Power auger borings are designated by the prefix "B".

Hand auger borings were advanced manually with a 1 1/2" diameter auger and were limited to the depth from which the auger could be manually withdrawn. Hand auger borings are indicated by the prefix "HA".

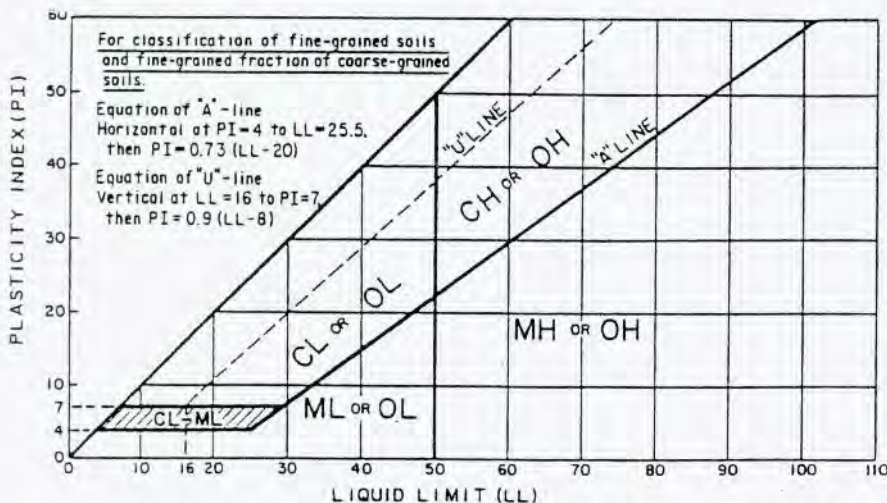
**Sampling.** All samples were taken with the standard 2" OD split-tube sampler, except where noted. TW indicates thin-walled (undisturbed) tube sample.

**BPF.** Numbers indicate blows per foot recorded in standard penetration test, also known as "N" value. The sampler was set 6" into undisturbed soil below the hollow-stem auger. Driving resistances were then counted for second and third 6" increments and added to get BPF. Where they differed significantly, they are reported in the following form: 2/12 for the second and third 6" increments, respectively.

**WH.** WH indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

**WR.** WR indicates the sampler penetrated soil under weight of rods alone; hammer weight and driving not required.

**Note.** All tests were run in general accordance with applicable ASTM standards.



### Laboratory Tests

DD	Dry density, pcf	OC	Organic content, %
WD	Wet density, pcf	S	Percent of saturation, %
MC	Natural moisture content, %	SG	Specific gravity
LL	Liquid limit, %	C	Cohesion, psf
PL	Plastic limit, %	$\phi$	Angle of internal friction
PI	Plasticity index, %	qu	Unconfined compressive strength, psf
P200	% passing 200 sieve	qp	Pocket penetrometer strength, tsf

# LOG OF BORING

PROJECT: 991097 GEOTECHNICAL EVALUATION Bluewater Spring Hatchery Improvements East of Bridger, Montana					BORING: ST-1		
					LOCATION: See attached sketch.		
DRILLER: WHN		METHOD: 3 1/4" HSA, Auto Hmr			DATE: 7/16/99	SCALE: 1" = 3'	
Elev. 102.0	Depth 0.0	ASTM Symbol	Description of Materials (ASTM D 2488)	BPF	WL	qp*	Tests or Notes
101.0	1.0	OL	ORGANIC CLAY with SAND and roots, low to medium plasticity, trace salts, light brown, rather dry, medium. (Topsoil)	3/4			Bag sample from 1' to 5'. Elevation Reference: CP #2, elev. = 101.30 used for Boring ST-1 through ST-3, HA-13 and HA-14.
		CL	LEAN CLAY with SAND, low to medium plasticity, trace salts and roots, light brown, rather dry, medium. (Alluvium)	10			
98.0	4.0	CL		TW			
		CH	LEAN to FAT CLAY, medium to high plasticity, trace Tufa Gravel, some calcium carbonate, light brown mottled white, rather dry, rather stiff. (Alluvium)	9			
96.0	6.0	CL	SANDY LEAN CLAY, medium plasticity, trace calcium carbonate, olive brown, moist, rather stiff to medium. (Alluvium)	10		4+	An open triangle in the water level column indicates the depth at which groundwater was first observed while drilling.
			-waterbearing at 9.9'.	8	▽	4+	
				7		2 1/2	
88.5	13.5	SC	CLAYEY SAND with GRAVEL, fine- to coarse-grained, medium plasticity, reddish brown and dark brown, waterbearing, very loose. (Alluvium)	3			*qp = pocket penetrometer estimate of unconfined compressive strength, tons per square foot.
86.5	15.5		END OF BORING				
			Water down 10' with 14' of hollow-stem auger in the ground.				
			Water down 9.9' immediately after withdrawal of auger.				

(See Report and Standard Plates for evaluation and descriptive terminology.)

# LOG OF BORING

PROJECT: <b>991097</b> <b>GEOTECHNICAL EVALUATION</b> <b>Bluewater Spring Hatchery Improvements</b> <b>East of Bridger, Montana</b>					BORING: <b>ST-2</b> LOCATION: See attached sketch.		
DRILLER: WHN		METHOD: 3 1/4" HSA, Auto Hmr		DATE: 7/16/99		SCALE: 1" = 3'	
Elev.	Depth	ASTM Symbol	Description of Materials (ASTM D 2488)	BPF	WL	qp	Tests or Notes
94.0	0.0		3" of topsoil and root zone over FILL: Sandy Lean Clay, low plasticity, trace cinders and roots, dark brown and tan, moist.	10		3/4	Spring water level elev. = 91.
92.0	2.0						
91.5	2.5	OL	ORGANIC CLAY with SAND, low to medium plasticity, some roots, dark brown, wet. (Buried Topsoil)	1/2			
90.5	3.5	CL					
		CL	SANDY LEAN CLAY, low plasticity, olive brown, wet, rather soft. (Alluvium)				
			LEAN CLAY, medium plasticity, trace organics, gray, waterbearing, soft to very soft. (Alluvium)	2			
				WH		0	
85.5	8.5						
		CL CH	LEAN to FAT CLAY, medium to high plasticity, trace Sand and fine Gravel, olive brown, waterbearing, soft to rather soft. (Alluvium)	2		0	
				4		1	
78.5	15.5			2		1/4	
			END OF BORING				
			Water down 10' with 14' of hollow-stem auger in the ground.				
			Water down 9.9' immediately after withdrawal of auger.				
			Water level is likely at same elevation as Bluewater Spring, elev. = 91.0.				

(See Report and Standard Plates for evaluation and descriptive terminology.)

# LOG OF BORING

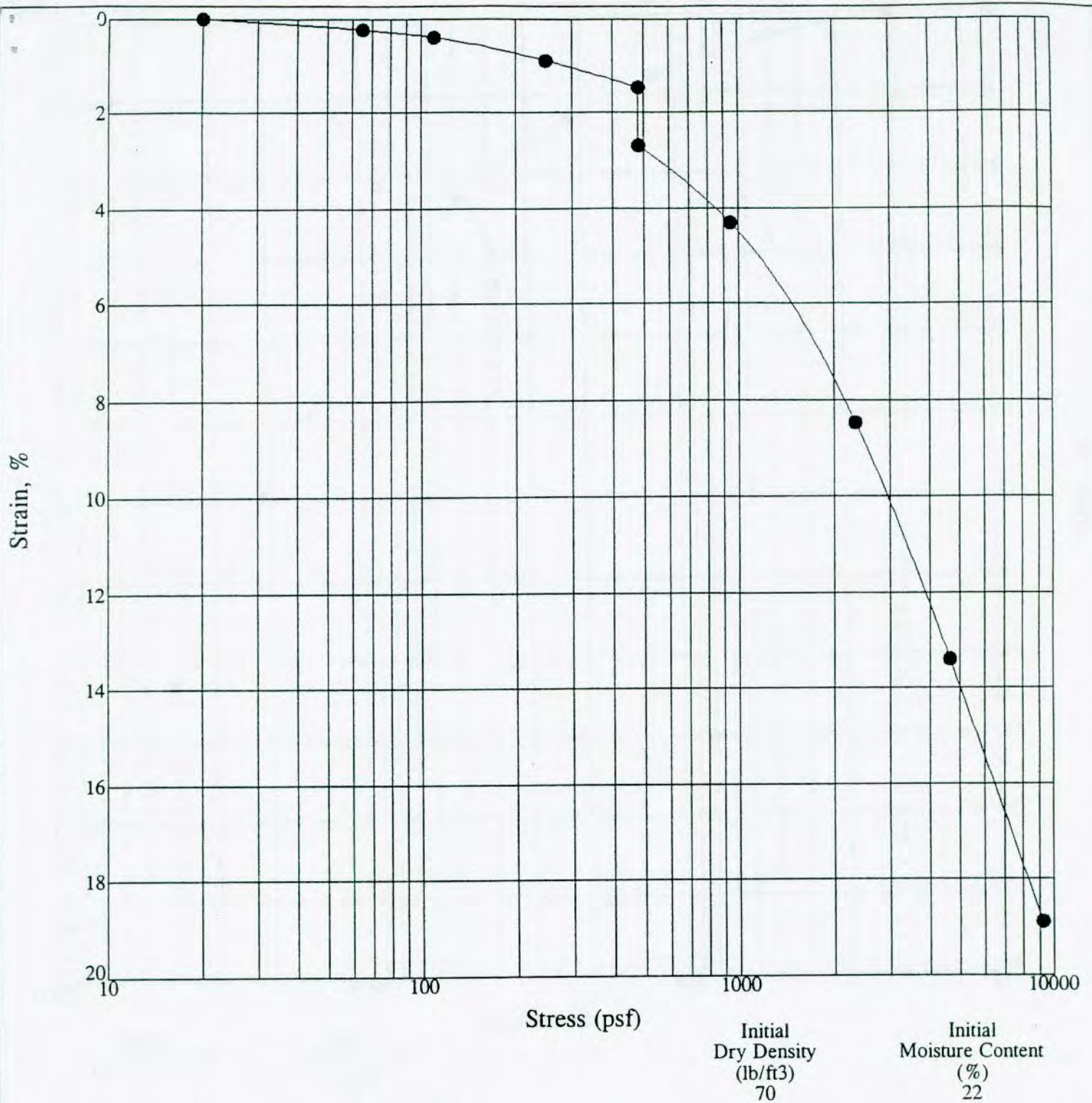
<b>PROJECT: 991097</b> <b>GEOTECHNICAL EVALUATION</b> <b>Bluewater Spring Hatchery Improvements</b> <b>East of Bridger, Montana</b>						<b>BORING: ST-3</b> <b>LOCATION:</b> See attached sketch.		
<b>DRILLER: WHN</b>			<b>METHOD: 3 1/4" HSA, Auto Hmr</b>		<b>DATE: 7/16/99</b>		<b>SCALE: 1" = 3'</b>	
Elev.	Depth	ASTM Symbol	Description of Materials (ASTM D 2488)	BPF	WL	qp	Tests or Notes	
88.8	0.0	CL	5" of topsoil and root zone over SANDY LEAN CLAY, low to medium plasticity, trace calcium carbonate, dark brown mottled white, rather dry to moist. (Alluvium)	15				
85.3	3.5	SM	SILTY SAND, fine- to coarse-grained, trace cemented Gravels, olive brown, wet, very loose. (Tufa)	7		2 1/2		
82.8	6.0	CL	LEAN CLAY with SAND, medium plasticity, trace calcium carbonate, grayish brown, rather wet, soft. (Alluvium)	3				
80.3	8.5	CL	LEAN CLAY with SAND, medium plasticity, trace calcium carbonate, grayish brown, rather wet, soft. (Alluvium)	2	▽	1 1/4		
		CL CH	LEAN to FAT CLAY with SAND, medium to high plasticity, trace calcium carbonate, olive and olive brown, wet, medium to rather soft. (Alluvium)	7		1/4		
			-mottled white at 12 1/2'.	7		1/2		
73.3	15.5			4		3/4		
<b>END OF BORING</b>  Water not observed with 14' of hollow-stem auger in the ground.  Water not observed to dry cave-in depth of 12' immediately after withdrawal of auger.  Hole left open and rechecked on 7/19/99. Groundwater observed at a depth of 6 1/2'.								

(See Report and Standard Plates for evaluation and descriptive terminology.)

# LOG OF BORING

<b>PROJECT: 991097</b> <b>GEOTECHNICAL EVALUATION</b> <b>Bluewater Spring Hatchery Improvements</b> <b>East of Bridger, Montana</b>					<b>BORING: ST-4</b> <b>LOCATION:</b> See attached sketch.				
<b>DRILLER: WHN</b>			<b>METHOD: 3 1/4" HSA, Auto Hmr</b>		<b>DATE: 7/16/99</b>		<b>SCALE: 1" = 3'</b>		
Elev.	Depth	ASTM Symbol	Description of Materials (ASTM D 2488)	BPF	WL	qp	Tests or Notes		
81.4	0.0								
78.9	2.5	CL	2" of Gravel Surfacing over SANDY LEAN CLAY, medium plasticity, with calcium carbonate, light brown mottled white, rather dry, rather stiff. (Tufa)	10			Elevation Reference: CP #4, elev. = 83.82 used for Boring ST-4 through ST-9.		
				8/8					
77.4	4.0	SM	SILTY SAND, fine- to coarse-grained, trace cemented Gravels, some calcium carbonate, light brown, rather moist, medium dense. (Tufa)						
		CL	SANDY LEAN CLAY, low plasticity, dark brown, wet, soft. (Alluvium)	2		1/4	Perched water on top of Lean to Fat Clay.		
				3		1/4			
72.9	8.5	CL	-trace humus at 7 1/2'.						
		CL CH	LEAN to FAT CLAY, medium to high plasticity, some Sand, trace lenses of calcium carbonate, olive, moist, medium to rather stiff. (Alluvium)	8		1 1/2			
				7		2			
65.9	15.5			10		1 1/2			
END OF BORING									
Water not observed with 14' of hollow-stem auger in the ground.  Water not observed to dry cave-in depth of 12' immediately after withdrawal of auger.									

(See Report and Standard Plates for evaluation and descriptive terminology.)



Boring: ST-12      Sample: ---      Depth: 3' to 4'  
Soil Description:      Sandy Lean Clay, low plasticity, olive brown, moist. (CL)

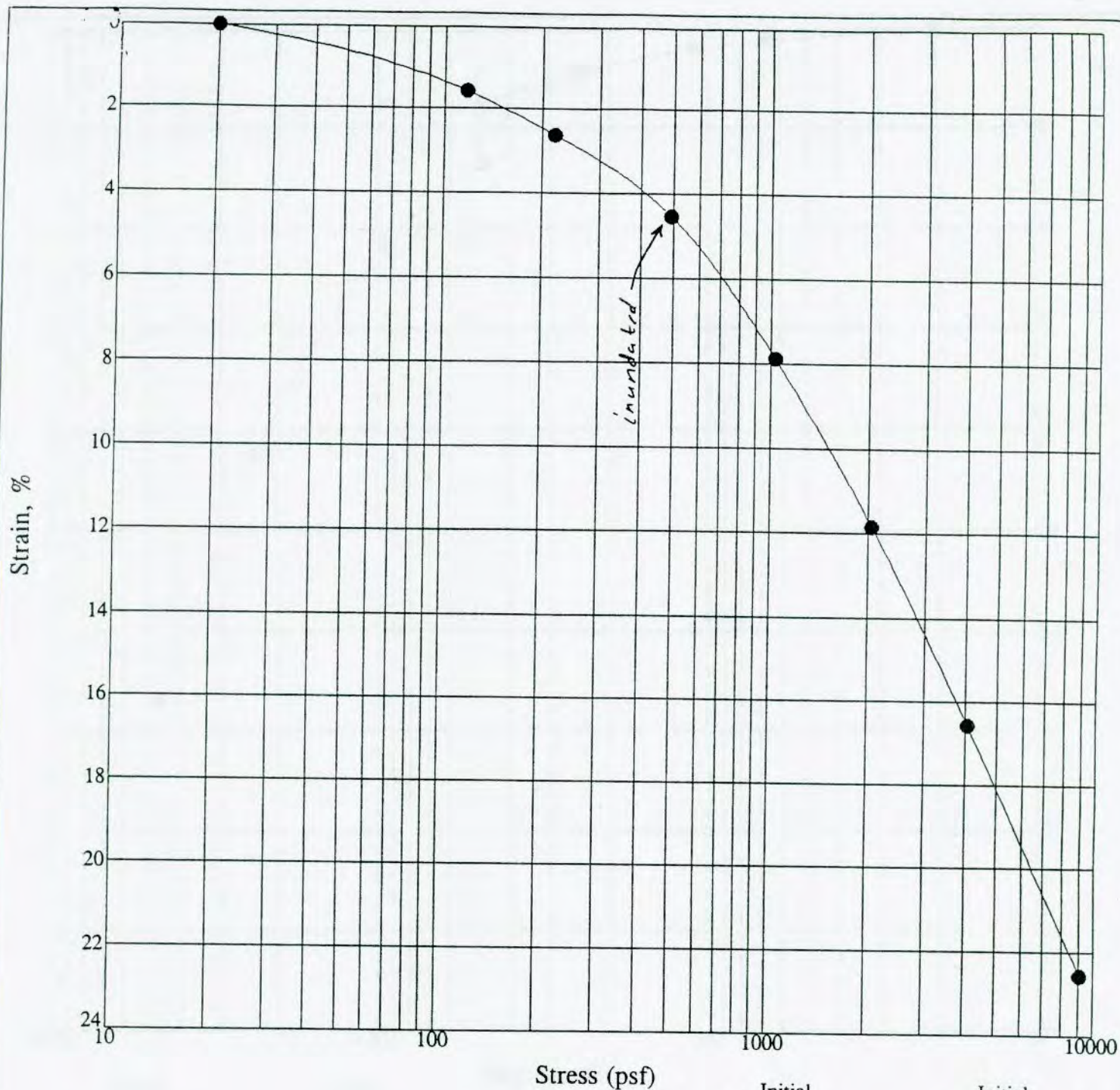
August 17, 1999

## Consolidation Test

Bluewater Spring Hatchery Improvements, East of Bridger, Montana

SK Geotechnical Corporation, Billings, Montana (406) 652-3930

Project 991097



Initial  
Dry Density  
(lb/ft<sup>3</sup>)  
64

Initial  
Moisture Content  
(%)  
55

Boring: HA-13      Sample: ---      Depth: 3'-3" to 3'-7"  
Soil Description:      FILL: Lean Clay, low plasticity, gray, moist.

August 12, 1999

## Consolidation Test

Bluewater Spring Hatchery Improvements, East of Bridger, Montana

SK Geotechnical Corporation, Billings, Montana (406) 652-3930

Project 991097

# LOG OF BORING

PROJECT: 991097 GEOTECHNICAL EVALUATION Bluewater Spring Hatchery Improvements East of Bridger, Montana					BORING: ST-5		
					LOCATION: See attached sketch.		
DRILLER: WHN		METHOD: 3 1/4" HSA, Auto Hmr			DATE: 7/15/99	SCALE: 1" = 3'	
Elev. 76.9	Depth 0.0	ASTM Symbol	Description of Materials (ASTM D 2488)	BPF	WL	qp	Tests or Notes
		CL	2" of topsoil and root zone over SANDY LEAN CLAY, low plasticity, trace roots and salts, brown, moist, medium. (Alluvium)	6			Bag sample from 1' to 5'.
74.9	2.0	SM	SILTY SAND with partially cemented GRAVELS, fine- to coarse-grained, some Clay, calcium carbonate, light brown and white, rather dry, medium dense. (Tufa)	12			
73.4	3.5	CL	LEAN CLAY, medium plasticity, trace salts, gray, moist, rather wet, soft. (Alluvium)	TW			
71.4	5.5	CL	SANDY LEAN CLAY, low plasticity, dark olive brown, wet, soft. (Alluvium)	2		1 1/4	
		CL	-2" lenses of black Sandy Lean Clay at 7 1/2'.	2		1/4	Floor, el. = 70 ////////////////////
68.4	8.5	CL	LEAN CLAY, low plasticity, trace Sand, dark olive brown, wet, soft to very soft. (Alluvium)	TW			
		CL	-trace lenses of Silty Sand at 12 1/2'.	2		0	
63.4	13.5	CH	FAT CLAY, high plasticity, trace humus, gray, wet, soft. (Alluvium)	3		1/4	
61.4	15.5		END OF BORING				
			Water not observed with 14' of hollow-stem auger in the ground.				
			Water not observed to dry cave-in depth of 12' immediately after withdrawal of auger.				

(See Report and Standard Plates for evaluation and descriptive terminology.)

# LOG OF BORING

<b>PROJECT: 991097</b> <b>GEOTECHNICAL EVALUATION</b> Bluewater Spring Hatchery Improvements East of Bridger, Montana					<b>BORING: ST-6</b> <b>LOCATION:</b> See attached sketch.		
<b>DRILLER: WHN</b>		<b>METHOD: 3 1/4" HSA, Auto Hmr</b>		<b>DATE: 7/15/99</b>		<b>SCALE: 1" = 3'</b>	
Elev.	Depth	ASTM Symbol	Description of Materials (ASTM D 2488)	BPF	WL	qp	Tests or Notes
76.6	0.0						
			FILL: Organic Clay with Sand, low plasticity, trace Tufa, some roots, brown, rather dry, medium.	7			
				10			
73.6	3.0						
		SM	SILTY SAND with partially cemented GRAVELS, fine- to coarse-grained, trace Clay, light brown, moist, very loose to loose. (Tufa)	2			
				7			
68.1	8.5						
		CL	LEAN CLAY, low plasticity, trace Sand, olive brown, wet, very soft. (Alluvium)	WH		1/4	
65.6	11.0						
		CL CH	LEAN to FAT CLAY, medium to high plasticity, trace iron deposits, olive brown mottled rust, wet, very soft. (Alluvium)	WH		1/2	
63.1	13.5			TW			
		SM	SILTY SAND, fine- to coarse-grained, trace calcium carbonate, lense of fine-grained Silty Sand, brown, waterbearing, very loose. (Alluvium)	2			
61.1	15.5						
			END OF BORING				
			Waterbearing soils observed at about 12 1/2' while drilling.				
			Water not observed with 14' of hollow-stem auger in the ground.				
			Water not observed to dry cave-in depth of 13' immediately after withdrawal of auger.				

(See Report and Standard Plates for evaluation and descriptive terminology.)

 Floor, el. = 70  
 ////////////////

# LOG OF BORING

<b>PROJECT: 991097</b> <b>GEOTECHNICAL EVALUATION</b> <b>Bluewater Spring Hatchery Improvements</b> <b>East of Bridger, Montana</b>						<b>BORING: ST-7</b>		
						<b>LOCATION:</b> See attached sketch.		
<b>DRILLER: WHN</b>			<b>METHOD: 3 1/4" HSA, Auto Hmr</b>		<b>DATE: 7/15/99</b>		<b>SCALE: 1" = 3'</b>	
Elev. 76.2	Depth 0.0	ASTM Symbol	Description of Materials (ASTM D 2488)	BPF	WL	qp	Tests or Notes	
		CL	2" of topsoil and root zone over SANDY LEAN CLAY, low plasticity, trace Tufa Gravel, light brown, rather dry, rather stiff to rather soft. (Alluvium)	10 4				
72.7	3.5	SM	SILTY SAND, fine-grained, trace lenses of Lean Clay, light brown, moist, loose. (Alluvium)	1/4				
70.2	6.0	CL	LEAN CLAY, low to medium plasticity, trace iron deposits, gray, wet, very soft. (Alluvium)	1		1/4	Floor, el. = 70 ////////////////	
67.7	8.5	CL CH	LEAN to FAT CLAY, medium to high plasticity, trace lenses of brown Silty Clay, black and gray, wet, soft to very soft. (Alluvium)	2		0		
			-olive brown at 12 1/2'.		▽	0		
62.7	13.5	CL ML	SILTY CLAY with SAND, slightly plastic, trace lenses of Silty Sand, olive brown, waterbearing, soft. (Alluvium)	2				
60.7	15.5		END OF BORING					
			Waterbearing soils observed at 13' while drilling.					
			Water not observed with 14' of hollow-stem auger in the ground.					
			Water not observed to dry cave-in depth of 11' immediately after withdrawal of auger.					

(See Report and Standard Plates for evaluation and descriptive terminology.)

# LOG OF BORING

PROJECT: <b>991097</b> <b>GEOTECHNICAL EVALUATION</b> <b>Bluewater Spring Hatchery Improvements</b> <b>East of Bridger, Montana</b>						BORING: <b>ST-8</b>		
						LOCATION: See attached sketch.		
DRILLER: WHN			METHOD: 3 1/4" HSA, Auto Hmr		DATE: 7/16/99		SCALE: 1" = 3'	

Elev.	Depth	ASTM Symbol	Description of Materials (ASTM D 2488)	BPF	WL	qp	Tests or Notes
73.7	0.0	CL					
72.2	1.5	SM	2" of topsoil and root zone over LEAN CLAY with SAND, low to medium plasticity, trace salts, light olive brown, rather moist, medium. (Alluvium)	6			Bag sample from 1' to 5'.    Floor, el. = 70 ///////////////
			SILTY SAND, fine- to coarse-grained, trace cemented Gravels, dark brown, very loose to medium dense. (Tufa)	2			
			-trace lense of Lean Clay at 5'.	3			
66.2	7.5	CL	LEAN CLAY, medium plasticity, trace Sand, calcium carbonate, dark brown, wet, soft to very soft. (Alluvium)	8/1			
				2	0		
60.2	13.5	CL		WH	0		
		CH	LEAN to FAT CLAY, medium to high plasticity, trace humus, dark gray, wet, very soft. (Alluvium)	WH	1/4		
58.2	15.5		END OF BORING				
			Water not observed with 14' of hollow-stem auger in the ground.				

(See Report and Standard Plates for evaluation and descriptive terminology.)

# LOG OF BORING

PROJECT: <b>991097</b> <b>GEOTECHNICAL EVALUATION</b> <b>Bluewater Spring Hatchery Improvements</b> <b>East of Bridger, Montana</b>						BORING: <b>ST-9</b>	
LOCATION: See attached sketch.							
DRILLER: WHN		METHOD: 3 1/4" HSA, Auto Hmr		DATE: 7/19/99		SCALE: 1" = 3'	

Elev.	Depth	ASTM Symbol	Description of Materials (ASTM D 2488)	BPF	WL	qp	Tests or Notes
71.6	0.0						
70.1	1.5	CL	4" of topsoil and root zone over SANDY LEAN CLAY, low plasticity, some Tufa Gravels, trace roots, brown, rather dry, rather stiff. (Alluvium)	9			
		SM	SILTY SAND, fine- to coarse-grained, some cemented Gravels, trace Clay and roots, brown, rather dry, loose to medium dense. (Tufa)	6			
				TW			
				17			
64.1	7.5	CL CH	LEAN to FAT CLAY, medium to high plasticity, trace humus, dark gray, moist to wet, medium to soft. (Alluvium)	9/3		2	
				TW			
			-reddish brown at 10'.	3		3/4	
				2		1/2	
58.1	13.5	SM	SILTY SAND, fine- to coarse-grained, some cemented Gravel, trace Clay lenses, brown, waterbearing, very loose. (Tufa)	2			
56.1	15.5		END OF BORING				
			Water down 15' with 14' of hollow-stem auger in the ground.				
			Water not observed to dry cave-in depth of 13' immediately after withdrawal of auger.				

(See Report and Standard Plates for evaluation and descriptive terminology.)

LL = 49, PL = 18  
 PI = 31  
 P200 = 97%

# LOG OF BORING

<b>PROJECT: 991097</b> <b>GEOTECHNICAL EVALUATION</b> <b>Bluewater Spring Hatchery Improvements</b> <b>East of Bridger, Montana</b>						<b>BORING: ST-10</b> <b>LOCATION:</b> See attached sketch.		
<b>DRILLER: WHN</b>		<b>METHOD: 3 1/4" HSA, Auto Hmr</b>		<b>DATE: 7/19/99</b>	<b>SCALE: 1" = 3'</b>			
Elev.	Depth	ASTM Symbol	Description of Materials (ASTM D 2488)	BPF	WL	qp	Tests or Notes	
70.5	0.0							
70.0	0.5		FILL: Sandy Gravel Surfacing.				Elevation Reference: CP #8, elev. = 55.19 used for Boring ST-10 through ST-12.	
		CL	SANDY LEAN CLAY, low plasticity, some Tufa Gravels, trace calcium carbonate, brown, rather moist, stiff to soft. (Alluvium)	16				
				3				
				TW				
65.5	5.0			3/8				
		SM	SILTY SAND, fine- to coarse-grained, some cemented Gravels, light brown, moist, medium dense to very dense. (Tufa)	50 for 5" set				
62.5	8.0							
		CL	SANDY LEAN CLAY, medium plasticity, trace lenses of humus, dark brown, wet, medium. (Alluvium)	6	1/2			
59.5	11.0							
		CL CH	LEAN to FAT CLAY, medium to high plasticity, olive brown and gray, wet, very soft. (Alluvium)	1	0			
57.0	13.5							
		SM	SILTY SAND, fine- to coarse-grained, some cemented gravels, olive brown and reddish brown, waterbearing, loose. (Tufa)	5				
55.0	15.5							
			END OF BORING					
			Water down 14 1/2' with 14' of hollow-stem auger in the ground.					
			Water not observed to dry cave-in depth of 13' immediately after withdrawal of auger.					

(See Report and Standard Plates for evaluation and descriptive terminology.)

# LOG OF BORING

<b>PROJECT: 991097</b> <b>GEOTECHNICAL EVALUATION</b> <b>Bluewater Spring Hatchery Improvements</b> <b>East of Bridger, Montana</b>						<b>BORING: ST-11</b>	
<b>LOCATION:</b> See attached sketch.							
<b>DRILLER: WHN</b>		<b>METHOD: 3 1/4" HSA, Auto Hmr</b>		<b>DATE: 7/19/99</b>		<b>SCALE: 1" = 3'</b>	
Elev.	Depth	ASTM Symbol	Description of Materials (ASTM D 2488)	BPF	WL	qp	Tests or Notes
56.4	0.0	CL	3" of topsoil and root zone over LEAN CLAY with SAND, low plasticity, trace roots and Tufa Gravel, light grayish brown, rather dry, rather soft. (Alluvium)	5			Bag sample from 1' to 5', see Proctor.
52.9	3.5	SM	SILTY SAND, fine- to coarse-grained, some cemented Gravel, light brown, rather dry to moist, dense to medium dense. (Tufa)	1/4			
46.4	10.0	ML	SANDY SILT, fine-grained, trace cemented Gravels, lenses of Clay, very loose. (Tufa)	37			
40.9	15.5		-waterbearing at 14 1/2'.	21			
			END OF BORING	22/2			
			Waterbearing soils observed at a depth of 14 1/2' while drilling.	2			
			Water not observed with 14' of hollow-stem auger in the ground.	2			
			Water not observed to dry cave-in depth of 11' immediately after withdrawal of auger.				

(See Report and Standard Plates for evaluation and descriptive terminology.)

# LOG OF BORING

<b>PROJECT: 991097</b> <b>GEOTECHNICAL EVALUATION</b> <b>Bluewater Spring Hatchery Improvements</b> <b>East of Bridger, Montana</b>					<b>BORING: ST-12</b> <b>LOCATION:</b> See attached sketch.				
<b>DRILLER: WHN</b>			<b>METHOD: 3 1/4" HSA, Auto Hmr</b>		<b>DATE: 7/19/99</b>		<b>SCALE: 1" = 3'</b>		
Elev.	Depth	ASTM Symbol	Description of Materials (ASTM D 2488)	BPF	WL	qp	Tests or Notes		
63.7	0.0								
63.2	0.5		FILL: Sandy Gravel Surfacing.						
		CL	LEAN CLAY with SAND, medium plasticity, some calcium carbonate, grayish brown mottled white, rather moist, medium. (Alluvium)	7			Bag sample from 1' to 5', LL = 32, PL = 17, PI = 15, P200 = 61%, see Proctor.		
61.7	2.0	CL	SANDY LEAN CLAY, low plasticity, trace lenses of Silty Sand, reddish brown and olive brown, moist, medium. (Alluvium)	7					
				TW					
59.7	4.0								
		SM	SILTY SAND, fine- to coarse-grained, some cemented Gravels, light brown, rather dry, medium dense to very dense. (Tufa)	12					
				7/14					
			-more cemented at 9 1/2'.	50 for 5"					
52.7	11.0								
		CL CH	LEAN to FAT CLAY, medium to high plasticity, trace humus, brown and gray, wet, soft to very soft. (Alluvium)	2		0			
				WH		1/2			
48.2	15.5								
			END OF BORING						
			Water not observed with 14' of hollow-stem auger in the ground.						
			Water not observed to dry cave-in depth of 13' immediately after withdrawal of auger.						

(See Report and Standard Plates for evaluation and descriptive terminology.)

# LOG OF HAND AUGER BORING

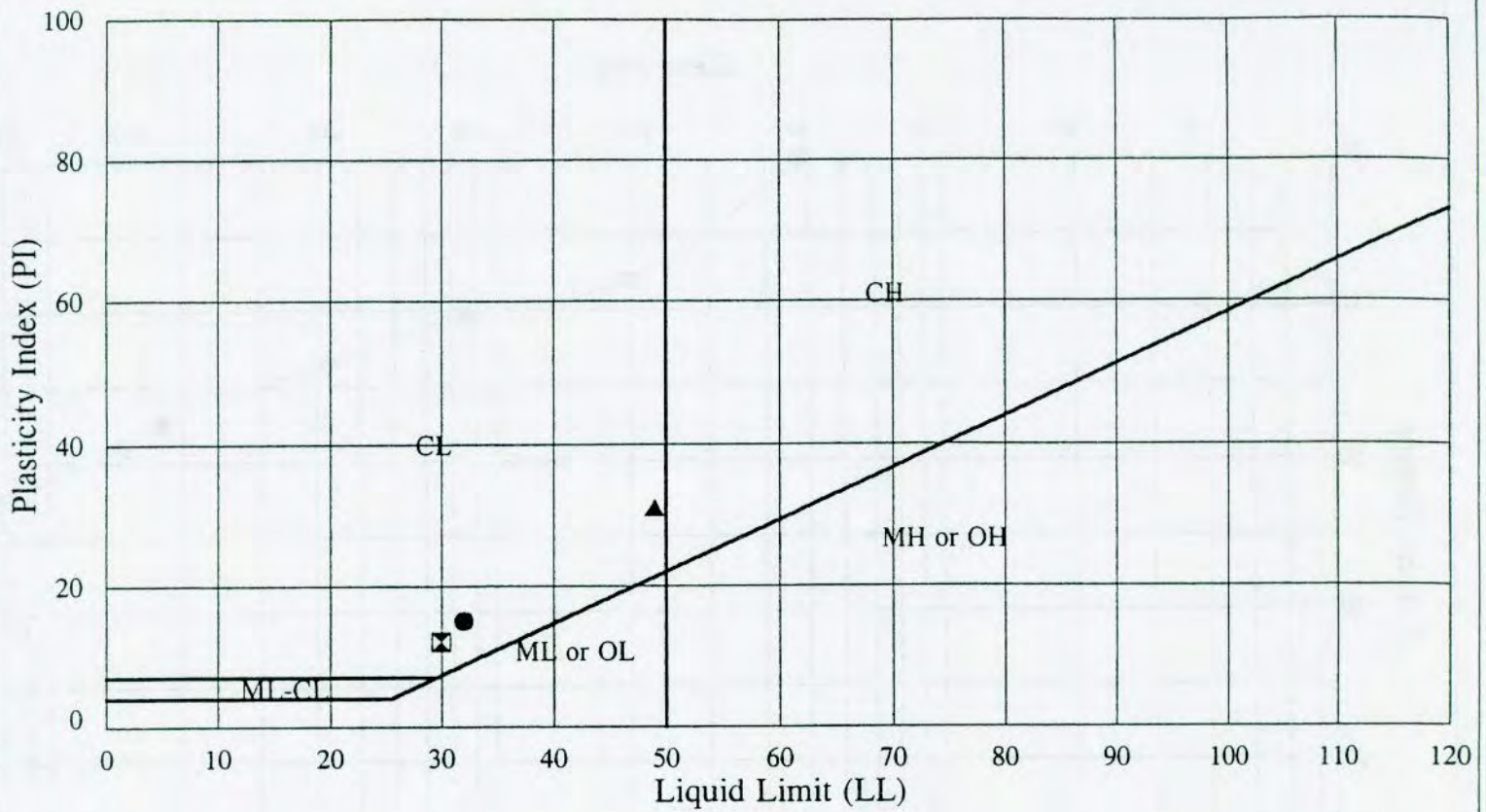
PROJECT: 991097 GEOTECHNICAL EVALUATION Bluewater Spring Hatchery Improvements East of Bridger, Montana				BORING: HA-13 LOCATION: See attached sketch.			
DRILLER: GTS/WHN		METHOD: Visual and Manual		DATE: 7/14/99		SCALE: 1" = 3'	
Elev.	Depth	ASTM Symbol	Description of Materials (ASTM D 2488)	B	WL	qp*	Tests or Notes
94.0	0.0						
93.6	0.4		FILL: Organic Clay with Sand, low plasticity, with roots, brown, rather dry.			5000+	
			FILL: Sandy Lean Clay, medium plasticity, trace salts and roots, dark brown, moist.			2700	
			-trace coarse salts below 2 1/2'.			1200	
						1500	
						1200	
						900	
89.6	4.4			CS	▽		CS = California Tube Sample
89.0	5.0	OL	ORGANIC CLAY with SAND, low plasticity, trace salts, decomposing odor, black, wet.				
		CL	(Buried Topsoil)				
		CH	LEAN to FAT CLAY with SAND, medium to high plasticity, trace roots, gray, wet, soft to medium. (Alluvium)			1000	*qp=proving ring and pocket
						1000	penetrometer estimate of unconfined
						1500	compressive strength, pounds per square
						1000	foot.
84.0	10.0		END OF HAND AUGER BORING			1000	
			Waterbearing clay soils at 3'.				

(See Report and Standard Plates for evaluation and descriptive terminology.)

# LOG OF HAND AUGER BORING

PROJECT: 991097 GEOTECHNICAL EVALUATION Bluewater Spring Hatchery Improvements East of Bridger, Montana					BORING: HA-14				
					LOCATION: See attached sketch.				
DRILLER: GTS/WHN			METHOD: Visual and Manual		DATE: 7/14/99		SCALE: 1" = 3'		
Elev.	Depth	ASTM Symbol	Description of Materials (ASTM D 2488)			B	WL	qp	Tests or Notes
94.4	0.0								
93.7	0.7	OH	ORGANIC CLAY, high plasticity, trace roots, dark brown, rather dry.					5000+	
		CL	LEAN to FAT CLAY, medium to high plasticity, some salts, gray and brown mottled white, moist. (Alluvium)					5000+	
		CH						4700	
90.9	3.5							3800	
90.4	4.0	SC	CLAYEY SAND with GRAVEL, fine- to coarse-grained, light brown, waterbearing. (Alluvium)					1800	
89.4	5.0	CL	LEAN to FAT CLAY, medium to high plasticity, brown and gray, moist. (Alluvium)					3000	Perched water.
		CH						3500	
			END OF HAND AUGER BORING						

(See Report and Standard Plates for evaluation and descriptive terminology.)



Legend	Boring No.	Sample No.	Location	LL	PL	PI	P 200	MC	Classification
●	ST-12	---	1' to 5'	32	17	15	60.9%		CL
⊠	ST-8	---	1' to 5'	30	18	12	55.8%		CL
▲	ST-9	---	8' to 9'	49	18	31	96.7%		CL

August 17, 1999

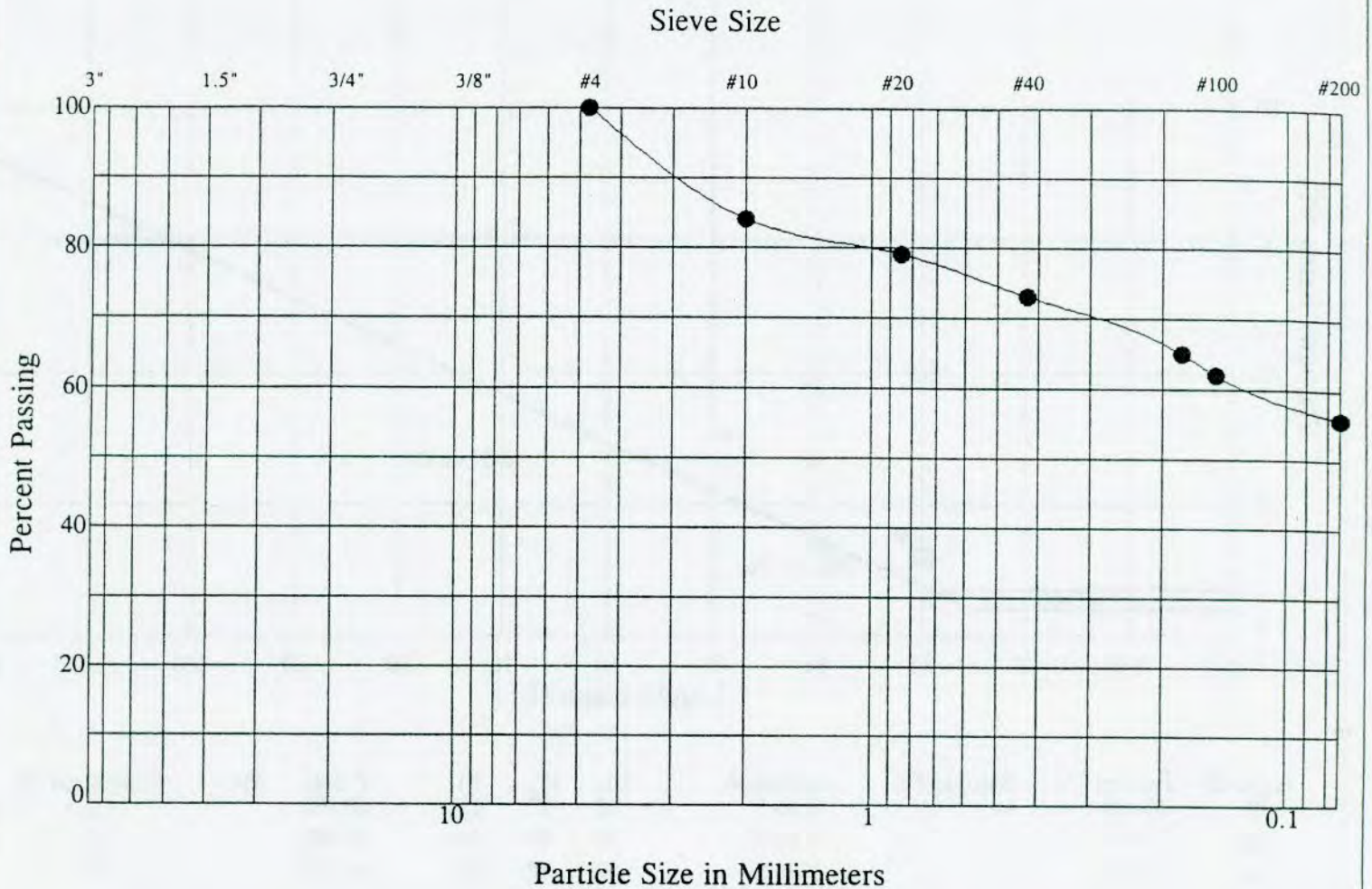
Project 991097

### Atterberg Limits' Tests

Bluewater Spring Hatchery Improvements, East of Bridger, Montana

SK Geotechnical Corporation, Billings, Montana (406) 652-3930

# Sieve Analysis



Gravel		Sand		
coarse	fine	coarse	medium	fine

Percent Passing U.S. Standard Sieve Size

3"	1 1/2"	3/4"	3/8"	#4	#10	#20	#40	#50	#100	#200
100	100	100	100	100	84	79	73	70	62	55.8

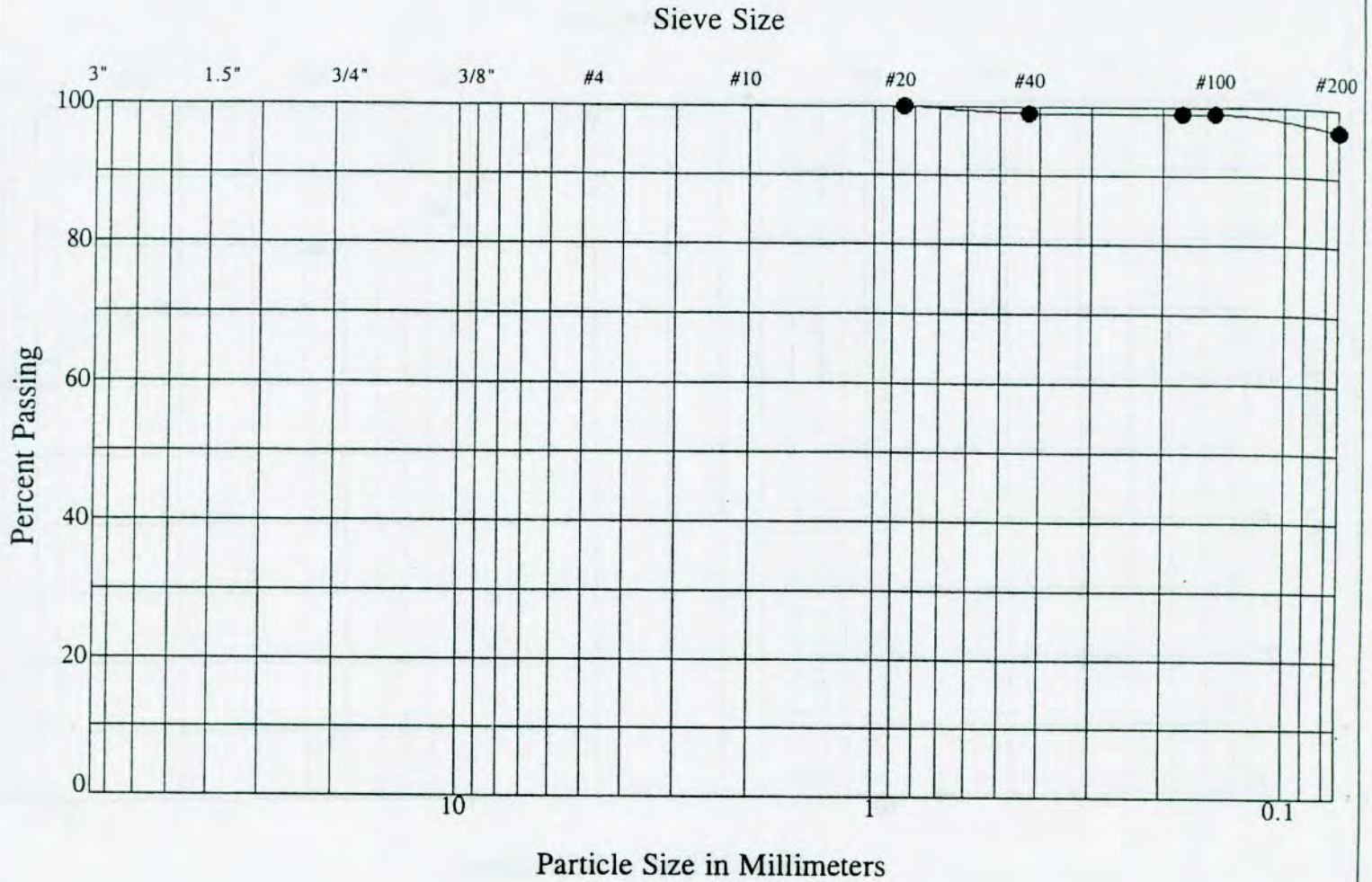
Sample No.: ---  
 Boring No.: ST-8  
 Location: 1' to 5'  
 Percent Gravel: 0.0  
 Percent Sand: 44.2  
 Percent Silt + Clay: 55.8  
 ASTM Group Name: Sandy Lean Clay

Liquid Limit: 30  
 Plastic Limit: 18  
 Plasticity Index: 12  
 Classification: CL  
 Moisture Content:

August 17, 1999

Bluewater Spring Hatchery Improvements, East of Bridger, Montana

# Sieve Analysis



Gravel		Sand		
coarse	fine	coarse	medium	fine

## Percent Passing U.S. Standard Sieve Size

3"	1 1/2"	3/4"	3/8"	#4	#10	#20	#40	#50	#100	#200
100	100	100	100	100	100	100	99	99	99	96.7

Sample No.: ---  
 Boring No.: ST-9  
 Location: 8' to 9'  
 Percent Gravel: 0.0  
 Percent Sand: 3.3  
 Percent Silt + Clay: 96.7  
 ASTM Group Name: Lean Clay

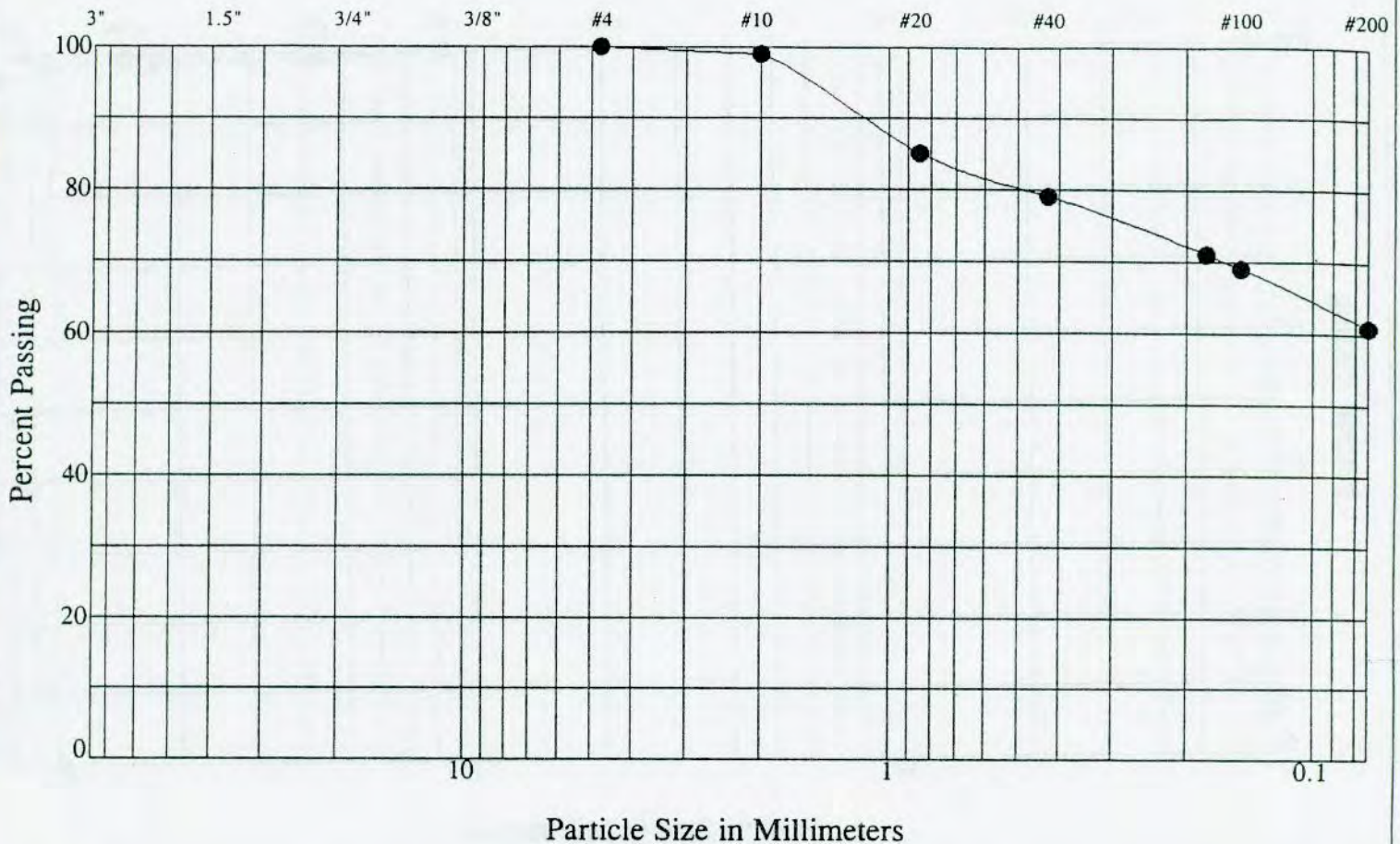
Liquid Limit: 49  
 Plastic Limit: 18  
 Plasticity Index: 31  
 Classification: CL  
 Moisture Content:

August 17, 1999

Bluewater Spring Hatchery Improvements, East of Bridger, Montana

# Sieve Analysis

Sieve Size



Gravel		Sand		
coarse	fine	coarse	medium	fine

## Percent Passing U.S. Standard Sieve Size

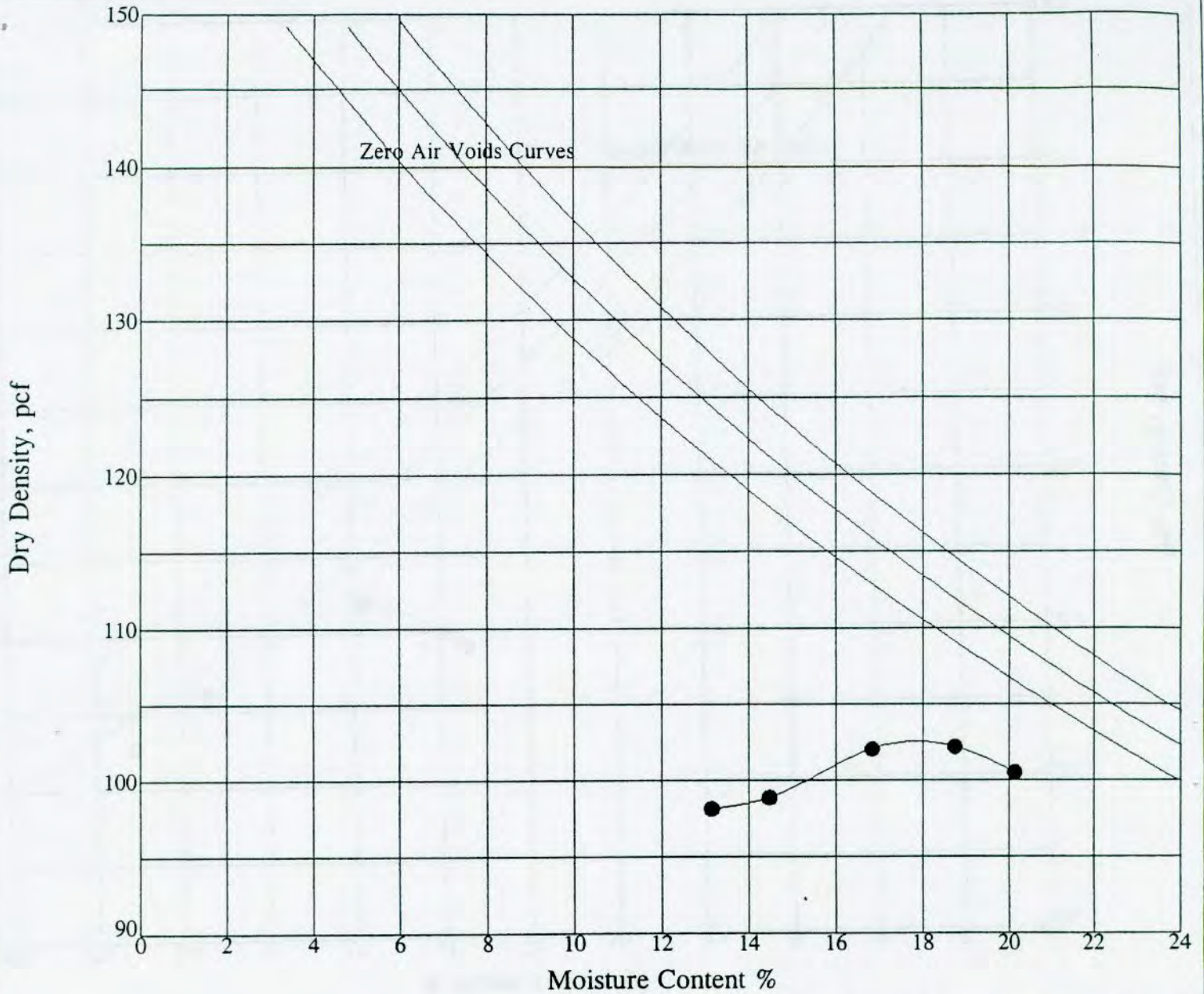
3"	1 1/2"	3/4"	3/8"	#4	#10	#20	#40	#50	#100	#200
100	100	100	100	100	99	85	79	76	69	60.9

Sample No.: ---  
 Boring No.: ST-12  
 Location: 1' to 5'  
 Percent Gravel: 0.0  
 Percent Sand: 39.1  
 Percent Silt + Clay: 60.9  
 ASTM Group Name: Sandy Lean Clay

Liquid Limit: 32  
 Plastic Limit: 17  
 Plasticity Index: 15  
 Classification: CL  
 Moisture Content:

August 17, 1999

Bluewater Spring Hatchery Improvements, East of Bridger, Montana



Sample No: ---

Lab Sample No: ST-11

Maximum Dry  
Density, pcf \*  
102.0

Optimum Moisture  
Content % \*  
15.0

Sampled From: 1' to 5'

Soil Description: Lean Clay with Sand, low plasticity, some tufa gravel, olive brown, moist. (CL)  
 ~3% aggregate retained on the 3/4" sieve.  
 ~8% aggregate retained on the 3/8" sieve.  
 ~12% aggregate retained on the #4 sieve.  
 Sampled by WHN with SKG.

ASTM D 698

Method: C

\*Density and moisture results  
rounded to nearest 0.5.

Job No:

991097

Appr:

Date:

8/17/99

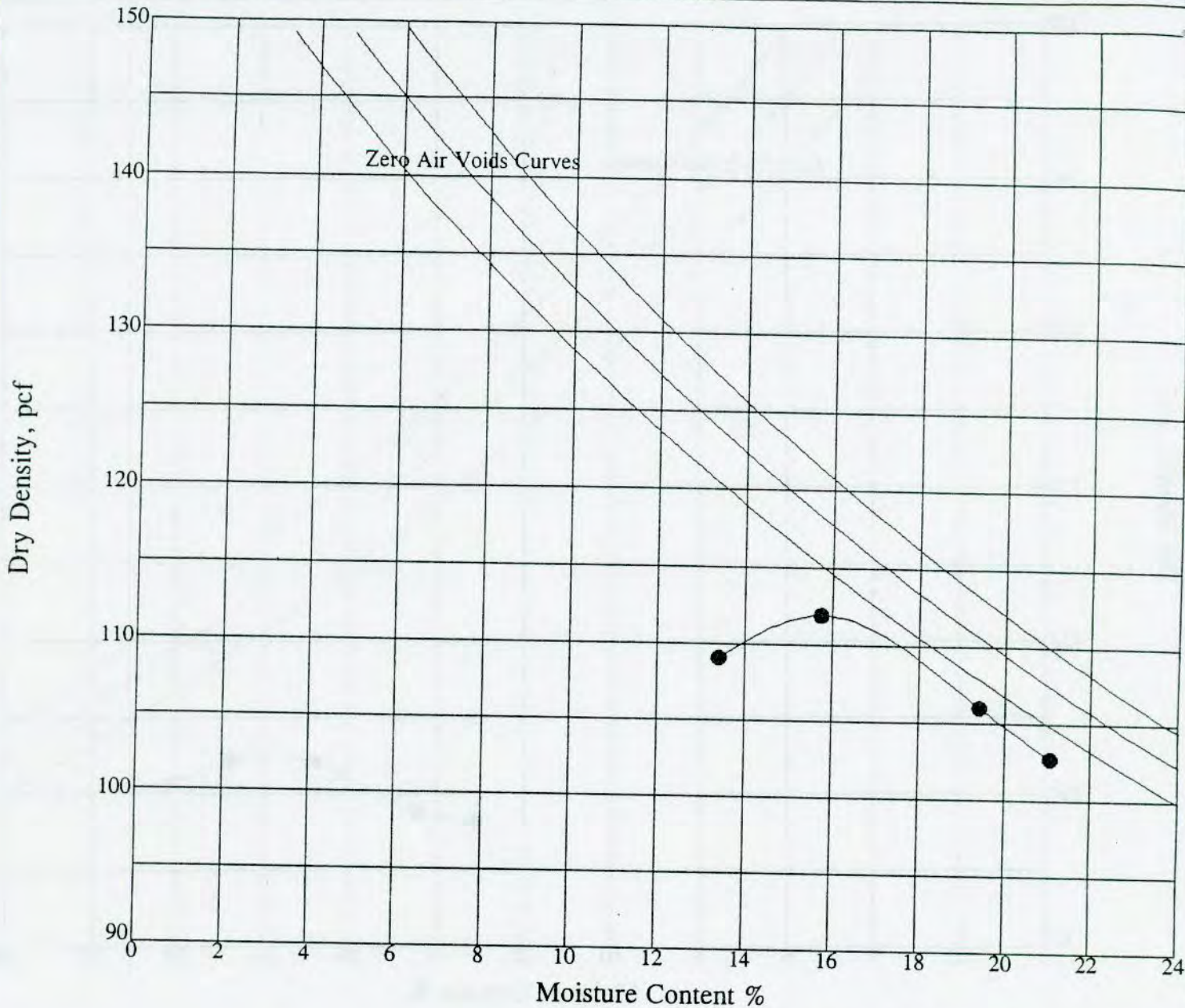
Laboratory Compaction Characteristics  
of Soil (Proctor)

Bluewater Spring Hatchery Improvements  
East of Bridger, Montana

SK Geotechnical Corporation, Billings, Montana

Plate

P-1



Sample No: ---

Sampled From: 1' to 5'

Soil Description:

Sandy Lean Clay, low plasticity, tufa particles, olive brown, moist. (CL)

~4% aggregate retained on the 3/4" sieve (discarded).

~13% aggregate retained on the 3/8" sieve.

~22% aggregate retained on the #4 sieve.

Sampled by WHN with SKG.

Lab Sample No: ST-8

Maximum Dry  
Density, pcf \*

112.0

Optimum Moisture  
Content % \*

16.0

ASTM D 698

Method: C

\*Density and moisture results  
rounded to nearest 0.5.

Job No:

991097

Appr:

Date:

8/17/99

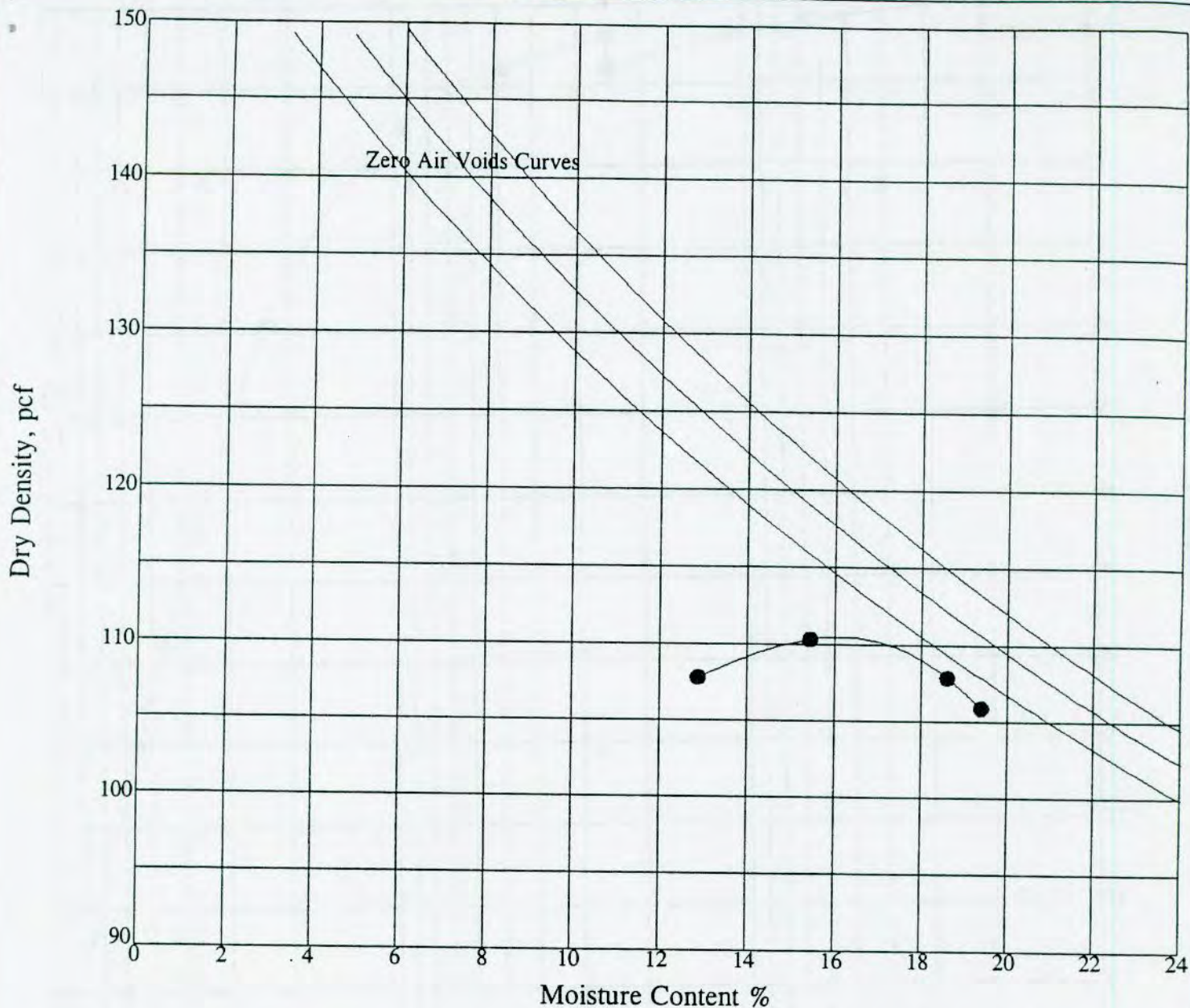
### Laboratory Compaction Characteristics of Soil (Proctor)

Bluewater Spring Hatchery Improvements  
East of Bridger, Montana

SK Geotechnical Corporation, Billings, Montana

Plate

P-2



Sample No: ---

Lab Sample No: ST-12

Maximum Dry  
Density, pcf \*  
110.0

Optimum Moisture  
Content % \*  
15.5

Sampled From: 1' to 5'

Soil Description: Sandy Lean Clay, low plasticity, some tufa gravel, brown, moist. (CL)  
 ~2% aggregate retained on the 3/4" sieve (discarded).  
 ~5% aggregate retained on the 3/8" sieve (discarded).  
 ~8% aggregate retained on the #4 sieve.  
 Sampled by WHN with SKG.

ASTM D 698

Method: B

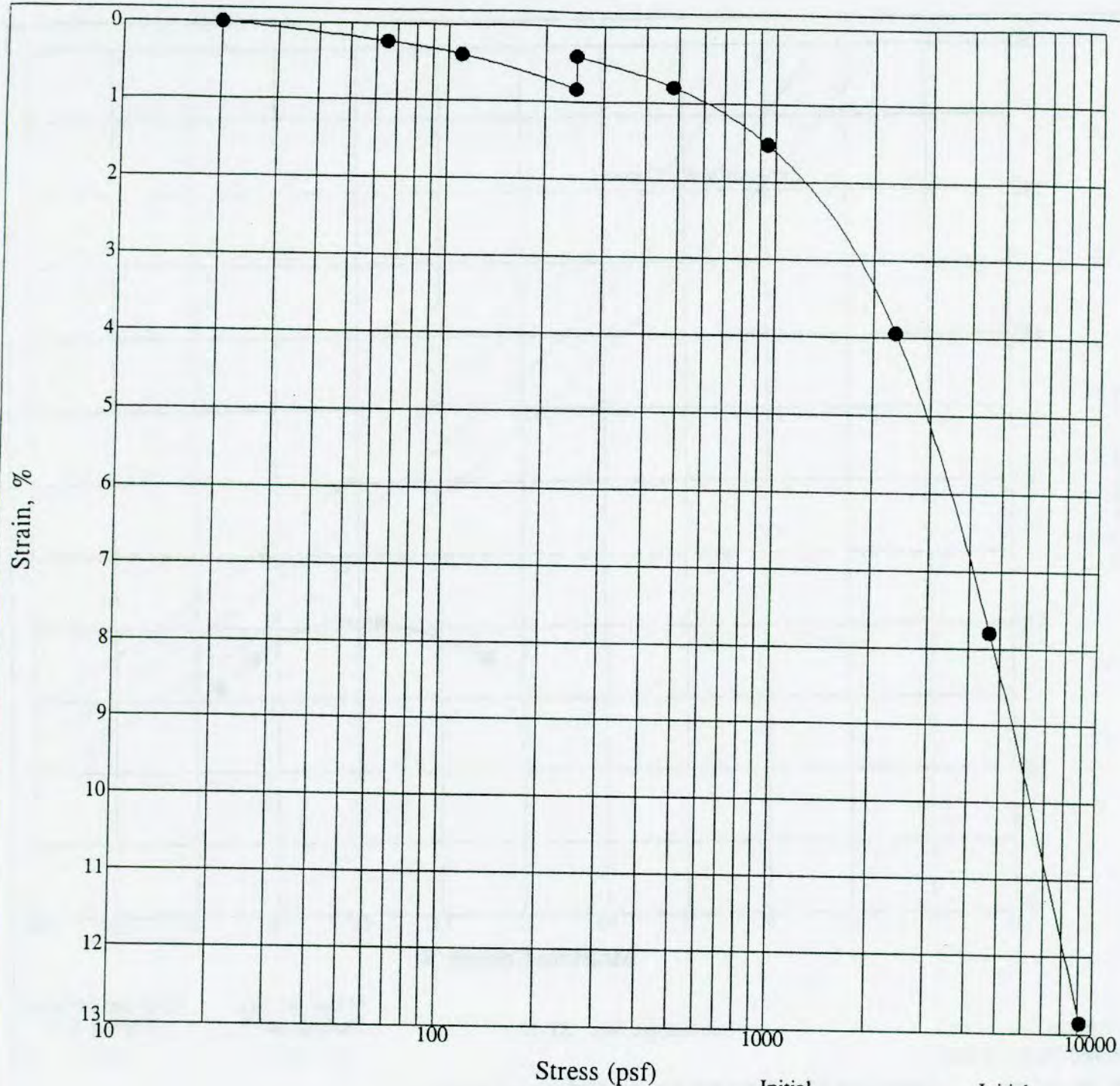
\*Density and moisture results  
rounded to nearest 0.5.

Laboratory Compaction Characteristics  
of Soil (Proctor)  
Bluewater Spring Hatchery Improvements  
East of Bridger, Montana

Plate

P-3

SK Geotechnical Corporation, Billings, Montana



Boring: ST-9    Sample: ---    Depth: 8' to 9'

Soil Description:    Lean to Fat Clay, medium to high plasticity, dark gray, moist to wet. (CL/CH)

Initial  
Dry Density  
(lb/ft<sup>3</sup>)  
86

Initial  
Moisture Content  
(%)  
25

August 17, 1999

## Swell Test

Bluewater Spring Hatchery Improvements, East of Bridger, Montana

SK Geotechnical Corporation, Billings, Montana (406) 652-3930

Project 991097

# TECHNICAL SPECIFICATIONS

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## SECTION 02/210

### EXCAVATION, BACKFILL AND EMBANKMENT FOR SUBSURFACE STRUCTURES

#### PART 1 - GENERAL

##### 1.1 DESCRIPTION

- A. This section consists of all excavation and incidental work necessary to provide the area required for the construction of underground structures, footings or appurtenances thereto. It shall include the disposal of all material removed, all bailing, pumping, and dewatering, all backfilling and compaction and all work, materials and equipment necessary to provide the area required for construction of the structure and subsequent backfilling.

##### 1.2 SITE CONDITIONS

- A. The **CONTRACTOR** shall satisfy himself as to the conditions that exist both above and below ground at the excavation site both prior to bidding and prior to construction. The **CONTRACTOR** shall submit to the **ENGINEER** a detailed description indicating method of excavation, supporting and dewatering the excavation throughout construction period.
- B. The **CONTRACTOR** shall confine his operation to within the construction limits indicated on the Plans. No operations shall be conducted outside the construction limits without prior written permission from the property **OWNER**.
- C. Boulders, logs, or other unforeseen obstacles encountered in the excavation shall be removed without additional compensation.

##### 1.3 LOCATION OF EXISTING UTILITIES

- A. The **CONTRACTOR** shall identify and locate in the field all utilities, below grade structures (when possible), public or private, that will affect the work before excavation commences. Whenever there is a direct conflict between the work being performed and known utilities, the **CONTRACTOR** shall be responsible to remove, relocate or temporarily support the utility during the course of construction. Any charges by the utility for removing, relocation or temporarily supporting the utility shall be paid for by the **CONTRACTOR**.

##### 1.4 NATURE OF MATERIAL

- A. Excavation, backfill, and embankment will be considered unclassified, except where "Structural Embankment" is designated under slabs and foundations. The **CONTRACTOR** shall remove all material, regardless of condition or composition to the lines and grades specified backfill with suitable embankment material and compact as

specified. Structural embankment shall conform to Section STRUCTURAL EMBANKMENT.

- B. It is mutually understood and agreed that the **CONTRACTOR** has conducted all site investigations necessary to ascertain the nature and requirements of the excavation and embankment, and has included in his bid price all labor, tools, equipment, materials and incidentals necessary to perform the work as specified.

## **PART 2 – MATERIALS AND EQUIPMENT**

### **2.1 BACKFILL MATERIALS**

- A. Material used for backfilling around structures shall be free from frozen lumps, wood, rocks larger than 3 inches in any dimension, or other deleterious materials. The moisture content shall be maintained within the limits necessary to achieve the compaction specified. Excessively wet material shall be dried or disposed of and replaced with suitable material before being used for backfill. All backfill material shall have a uniform consistency in the entire fill and shall have a maximum plasticity index of 8.

### **2.2 EQUIPMENT**

- A. The **CONTRACTOR** shall provide and have on site, in working condition, all excavating, backfilling, compacting, fine grading, dewatering, and other equipment and materials necessary to perform the excavation before starting the work.

## **PART 3 – EXECUTION**

### **3.1 STRIPPING TOPSOIL**

- A. Topsoil shall be removed to full depth of the topsoil or to a maximum depth of 24 inches, whichever is less.

### **3.2 EXCAVATION**

- A. The **CONTRACTOR** shall excavate to the lines and grades indicated on the Plans and as necessary to effectively install the structure. Material removed from the excavation shall be stockpiled a sufficient distance away to prevent any surcharge from affecting the stability of the excavation.
- B. Where concrete is to be placed on any excavated surface, special care shall be taken not to disturb the bottom of the excavation more than necessary. The final removal of the material to grade shall not be made until just before the concrete is placed. All seams or crevices shall be cleaned out and filled when concrete is placed. All seams or crevices shall be cleaned out and filled with concrete mortar. Then the excavation is at the required depth, all water shall be pumped out, if possible, for cleaning the foundation bed for inspection. The natural ground adjacent to the structure shall not be disturbed.

### 3.3 PUMPING

- A. Pumping from the interior of any foundation enclosure, when needed, shall be done in such a manner to preclude the possibility of any portion of the concrete materials being carried away. No pumping will be permitted during the placing of concrete or for a period of at least 24 hours thereafter unless it is done from a sump separated from the concrete work by a watertight wall.
- B. A Montana Department of Environmental Quality Permit shall be secured by the **CONTRACTOR** to discharge to any surface water course or drainage leading thereto. Water shall be disposed of in the manner specified in the Discharge Permit, and the **CONTRACTOR** shall perform and submit all testing required by Montana Department of Environmental Quality for demonstration of permit compliance. The **CONTRACTOR** shall hold the **OWNER** and **ENGINEER** harmless from any claims resulting from the proper disposal of groundwater. When required, the **CONTRACTOR** shall secure all necessary discharge permits or licenses.
- C. Dewatering operations shall be continuous and uninterrupted throughout the period of construction of the structure and shall be continued until such time that the structure has achieved its design strength, unless otherwise specifically authorized in writing by the **ENGINEER**. The **CONTRACTOR** shall be fully responsible for maintaining and tending his dewatering operation and shall replace any structure damaged as a result of failure of the dewatering equipment at no additional cost to the **OWNER**.
- D. The **CONTRACTOR** shall utilize proper dewatering methods and equipment to avoid hydraulic undermining of the structure foundation.

### 3.4 PREPARATION OF SUBGRADE

- A. Excavated subgrades under footings, fills and embankments shall be leveled, watered as necessary to achieve optimum compaction, and compacted to a density of no less than 98 percent with mechanical plate tampers or vibrating compacting equipment.
- B. All deleterious material in the subgrade shall be removed to the extent determined by the **ENGINEER** and replaced with suitable embankment material and compacted as specified above.
- C. Subgrades shall be protected from excessive moisture until footings or fill material are in place. Any subgrade saturated by rain or flooding shall be recompact after the excess moisture has been removed and before footings or fill are placed.
- D. Subgrades shall be finished to plus or minus 0.1 foot of grade.

### 3.5 BACKFILL AND EMBANKMENT

- A. Backfill around foundation walls shall be continued simultaneously on both sides of the wall to prevent placing excessive lateral force on the walls. Where backfill or embankment is to extend higher on one side than on the other, as indicated on the Plans, structural floors, beams or other means of restrain shall be installed before such backfill or embankment is placed. Should any deflection of the foundation wall result from the

**CONTRACTOR'S** failure to provide adequate bracing, the **CONTRACTOR** shall remove the backfill or embankment at no additional cost to the **OWNER**.

- B. Backfill and embankment shall be placed in uniform lifts not exceeding 8 inches in compacted thickness, watered to achieve optimum moisture content, and compacted to the following densities; as determined by ASTM Test Method D698:

Backfill under interior floor	
Slabs to 5' below:	98%

Backfill under interior floor	
Slabs below 5':	95%

Embankment outside of the	
Footings lines, full depth:	95%

- C. Backfill and embankment shall be finished to plus or minus 0.1 feet of grade under slabs and plus or minus 0.2 feet outside of the building lines.
- D. Compaction of fills and embankment shall be achieved with a steel drum vibratory roller weighing not less than 5 tons with a dynamic force not less than 20,000 pounds. Use of the roller shall be restricted to areas 5 feet from foundation walls. Smaller, walk-behind or vibratory plate compactors or whackers shall be used within 5 feet of foundation walls or on the entirety of smaller structures.
- E. Topsoil shall be placed over compacted embankment in areas to be landscaped or seeded. The final grade after topsoil placement shall match the elevations defined in the plans. Minimum depth of topsoil is 4-inches. The upper 4 to 6-inches of topsoil shall not be compacted.

### 3.6 UNIFORMITY OF BACKFILL AND EMBANKMENT

- A. All backfill and embankment material shall be selectively placed to provide a uniform consistence of material throughout the fill.
- B. A uniform moisture content shall be maintained at or near optimum throughout the fill to achieve maximum and uniform compaction.
- C. All soft, spongy areas shall be excavated and the unstable material shall be replaced with suitable material and compacted as required.

### 3.7 TESTING AND INSPECTION

- A. All backfill and embankment will be subject to inspection and testing. No further work shall proceed until all tests and inspections have been satisfactorily completed and approval has been given to proceed.
- B. The following tests and inspections will be performed:

1. Compaction of fill and embankments

2. Materials quality; and
3. Grade and surface smoothness.

**END OF SECTION 02/210**

**SECTION 02/218**  
**STRUCTURAL EMBANKMENT**

**PART 1 - GENERAL**

1.1 DESCRIPTION

- A. This section covers the methods and materials to be used for all structural embankments under structures.

1.2 RELATED WORK

- A. 02/210 Excavation, Backfill and Embankment for Subsurface Structures.

1.3 SUBMITTALS

- A. The CONTRACTOR shall provide the following submittals:
  - 1. Gradation test of structural embankment
  - 2. Laboratory moisture – density curves

1.4 REFERENCE STANDARDS

- A. Compaction: maximum density as determined by ASTM Test Method D698.

1.5 USE OF STRUCTURAL EMBANKMENT

- A. Structural Embankment is required for a minimum depth of 12-inches beneath all concrete slabs and footings.

**PART 2 - MATERIALS**

2.1 STRUCTURAL EMBANKMENT

- A. Structural embankment shall consist of the following materials:
  - 1. Three inch minus pitrun, uniformly graded, non-plastic, less than 10% passing the #200 sieve.

## **PART 3 – EXECUTION**

### **3.1 SUBGRADE PREPERATION**

- A. The existing ground to receive structural embankment shall be stripped of all topsoil, organic material, debris, large rocks. Concrete and other undesirable materials, scarified to a depth of 6-inches, wetted or dried to optimum moisture and compacted to 98%.

### **3.2 STRUCTURAL EMBANKMENT**

- A. Structural Embankment placed below footings shall be placed in uniform layers not to exceed 12-inches in loose thickness, brought to optimum moisture, and compacted to 98 percent by hand –operated mechanical tampers.
- B. Structural embankment below slabs shall be placed in uniform 12-inch lifts brought to optimum moisture, and compacted to 98 percent by hand –operated mechanical tampers.
- C. Backfill on sides of structures shall be native materials brought up evenly and compacted uniformly on all sides of the structure to avoid excessive stresses on the structures.
- D. The CONTRACTOR shall be responsible for locating and transporting all materials to the site as well as paying any processing costs and /or royalties associated with the materials.

**END OF SECTION 02/218**

## **SECTION 02/550**

### **BARBED WIRE FENCE**

#### **PART 1 - SCOPE**

##### **1.1 DESCRIPTION**

- A. This section covers the supply and installation of barbed wire fencing and metal gates.

##### **1.2 SUBMITTALS**

- A. The following submittals shall be provided in accordance with the General Conditions:
  - 1. Manufacturers' data sheets on all materials used, including but not limited to: wire, fence posts, and gates.

#### **PART 2 – MATERIALS**

##### **2.1 BARBED WIRE**

- A. Barbed wire shall be zinc-coated, steel barbed wire meeting the requirements of ASTM A121. Breaking strength of stand wire shall not be less than 950 pounds. Barbs shall be uniformly spaced from 4 to 5 inches apart. Minimum weight of zinc coating shall be Class I, except that minimum weight coating for 15 2-gauge strand wire shall be class 3. Barbed wire shall be two-point barbed unless specified otherwise.

##### **2.2 BRACE WIRE**

- A. The wire shall be gauge 9, soft.

##### **2.3 STAPLES AND NAILS**

- A. Wire staples of the barbed U-shaped type shall not be less than 9 gauge, 1 3/4-inches long. Nails shall be a type approved by the Engineer.

##### **2.4 TIE WIRES**

- A. Tie wire shall not be lighter than gauge 12.2. Commercial fasteners supplied with the wire may be used when approved. All shall be galvanized.

##### **2.5 METAL FENCE STAYS**

- A. Metal fence stays shall be standard make. They shall be fabricated from gauge 9 2 wire base and twisted to form a 2-wire unit.

## 2.6 WOOD FENCE POSTS AND BRACE RAILS

- A. Posts and brace rails shall be made from western larch, lodgepole pine, ponderosa pine, or douglas fir. They shall have the bark removed, be well seasoned, sound and straight grained.
- B. Posts shall be finished natural round.
- C. Corner, end, gate, pull and brace posts shall be a minimum of 6-inches in diameter and 8-feet long.
- D. A post with a bow of more than 2-inches in 8-feet will be rejected.
- E. Posts shall be treated with a minimum of 0.6 pcf of Chromated Copper Arsenic (CCA), type B or C, or Alkaline Copper Quaternary (ACQ) conforming to AWWPA standards. Treatment length for posts shall extend 48-inches. The treated end shall be placed in the ground.
- F. Posts shall be tapered for driving is about 8 to 12-inches to a 1-inch point on the lower end. The top of the post shall be tapered for a minimum of 4-inches to a round top with a minimum of 3-inches in diameter for line posts and a minimum of 5-inches in diameter for all other posts. The taper is included in total post length. Posts shall be tapered prior to treatment.

## 2.6 METAL LINE POSTS

- A. Line posts shall be studded steel "T" posts, minimum 1.25 lbs/ft, 6.5-feet long constructed of ASTM A499, grade 60 steel. Post shall be coated with baked green enamel paint.
- B. Use wire ties supplied by post manufacturer to attached barbed wire to metal fence posts.

## 2.7 METAL GATES

- A. Each gate shall be furnished complete with hinges and a latch and other required hardware and accessories.
- B. Gated shall not exceed 50-inches in height.
- C. Gate panels shall be constructed of a 2-inch tubular steel frame with a minimum of four horizontal tubular or U-shaped steel cross members and four vertical steel supports.
- D. Gates shall be factory coated with a high quality enamel paint or equivalent product that is neutral in color.

## 2.8 DEADMAN OR ANCHOR

- A. A deadman shall be a minimum 150 pound Portland cement concrete block. Deadman may be cast in place when approved by the Engineer. An anchor may be a steel or iron bar or rod at least 1 ¼-foot in diameter by 3-feet long with provisions on one end so a brace wire can be secured.

## 2.9 CONCRETE

- A. Concrete shall be 3000 psi strength concrete meeting the requirements of the technical specification 03/300, Cast in Place Concrete.

# PART 3 – EXECUTION

## 3.1 GENERAL

- A. Irregularities in the ground line shall be corrected as directed by the Engineer. All trees, rocks and shrubs shall be removed and disposed of. Clearing and leveling shall be completed with minimum disturbance to the terrain outside of the fence line.
- B. Posts may be driven or excavated. Posts damaged by driving shall be replaced at the Contractors expense. Posts shall be plumb and straight to grade. Excavated post holes shall be backfilled in 6-inch lifts with each lift solidly tamped and compacted.
- C. Posts holes for posts set in concrete shall be thoroughly wet when concrete is placed. Concrete shall be fully set prior to stretching wire or attaching gates.
- D. Barbed wire shall be attached after posts and footings have been firmly set. Wire shall be placed, tightly stretched and fastened to the posts. Tension shall be applied in accordance with the wire manufacturer's recommendations using a mechanical stretcher or device designed for such use.
- E. Barbed wire shall be wrapped around the terminal posts and fastened to itself with at least four turns. Fence wire shall be placed on the side of the fence facing the roadway and shall be placed on curves so that the wire force is against the posts.
- F. U-shaped staples shall be driven diagonally across the grain so that both points do not enter between the same grain. In depressions where wire uplift occurs, staples shall be sloped with points slightly upwards. On level ground and over knolls, staples shall be sloped slightly downward. Wire shall be stapled tightly at corner, end and pull posts. On line posts staples shall not be driven so tightly as to prevent movement of the wire or cause damage to the wire.
- G. At grade depressions, alignment angles and other places where stresses tending to pull posts from the ground or out of alignment are created, the fence shall be snubbed or guyed at the critical points by a brace wire attached to each horizontal line of fence. The combined ends of the brace wire shall be firmly attached to a deadman buried not less than 2-feet in the ground or to an approved anchor point that will best serve to resist the

pull of the wire fence. Deadman may also be fastened to posts. The locations of deadman shall be as directed in accordance with these specifications.

- H. When wooden fence posts are used for the fence, one metal line post shall be installed for each 500-foot run of fence and in runs of lesser length between gate posts to serve as lighting protection.
- I. Upon completion fence shall be true to line and grade, all posts shall be vertical and firm, all wire shall be taut, and the completed fence acceptable in all respects. Gates shall operate freely and properly. No openings shall be left that would allow stock or other animals to pass through the fence.

**END OF SECTION 02/550**

## **SECTION 02/713**

### **WATER PIPING**

#### **PART 1 - GENERAL**

##### **1.1 DESCRIPTION**

- A. This section defines the construction of water piping and appurtenances.

#### **PART 2 - SPECIFICATIONS**

##### **2.1 GENERAL**

- A. The following reference specifications shall be used to construct water piping and appurtenances:

Montana Public Works Standard Specifications (6<sup>th</sup> Edition)

Section 02221 - Trench Excavation and Backfill for Pipelines and Appurtenant Structures

Section 02660 – Water Distribution Systems

#### **PART 3 – MODIFICATIONS TO REFERENCED SPECIFICATIONS**

##### **3.1 TESTING PROVIDED BY CONTRACTOR**

- A. All references to density control testing shall be modified in the specifications listed in section 2.1.A as appropriate, to comply with the following:

A. Density Testing

1. In place field density testing shall be provided, coordinated and paid for by the Contractor. The Contractor shall secure the services of a qualified independent testing laboratory, subject to the approval of the Engineer, to provide proctors, density testing and other materials testing as specified.
2. Field Density Testing of earthwork and base course compaction shall meet AASHTO T310 (ASTM D6938) Nuclear Dosimeter methods.

3. Testing shall be provided at the following frequencies:
  - a. A total of 24 field density tests shall be provided for the trench backfill of water mains. Tests shall be spaced at roughly 50-feet horizontally along the pipe alignment and shall be evenly distributed vertically throughout the trench backfill.

### 3.2 HDPE PIPING

- A. The following specifications shall be added to include the use of HDPE piping:

#### **PART 2 – PRODUCTS**

##### 1. HDPE PIPE AND FITTINGS

- A. Pipe material shall be extra high molecular weight (EHMW) high density polyethylene with a standard thermoplastic material designation code of PE 4710 have a cell classification code of 445576C or 445574C per ASTM D3350.
- B. Pipe shall be DR 11 or DR 17 as listed in the drawings. Pipe shall be iron pipe size (IPS).
- C. Pipe and fittings shall meet the requirements of AWWA C906-07 IPS Polyethylene Pipe and Fittings, 2 inch through 63 inch for Water Distribution.
- D. Pipe shall be homogeneous throughout, free of visible cracks, holes foreign inclusions, blisters, dents or other injurious defects. The pipe shall be as uniform as practicable possible in color, opacity, density and other physical properties.

#### **PART 3 – EXECUTION**

##### 1. PIPE JOINING

- A. Buried and exposed pipe shall be joined by heat fusion or through the use of electrofusion couplings. Pipe joining shall be performed in accordance with the manufacturer's recommendations.
- B. Pipe connection to other pipe material shall be made through the use of flanged adapters with ductile iron back up rings. Flanged joints shall include 1/8-inch neoprene flange gaskets and stainless steel 304 flange bolts.

##### 2. DISINFECTION

- A. Disinfection and bacteriological testing of the piping is not required.

### 3.3 MEASUREMENT AND PAYMENT

- A. Part 4: Measurement and Payment shall be removed from all specifications listed in section 2.1.A.

**END OF SECTION 02/713**

## SECTION 02/931

### SEEDING

#### PART 1 GENERAL

##### 1. GENERAL

- A. This work shall consist of ground surfacing preparation; executing Summer Erosion Control Procedures; furnishing and planting seed; mowing; tracking; and cleanup. The work includes permanent seeding. Seed shall be applied to all project areas requiring revegetation. All construction disturbed areas shall be revegetated, including road right-of-ways; and excluding the installed roadways, and drivable alleys.
- B. Contractor shall topsoil and seed all disturbed areas unless indicated otherwise elsewhere on the plans.

#### PART 2 CERTIFICATIONS

##### 1. INDIGENOUS SEED CERTIFICATION

- A. Defined by MCA 80-5-101(4): “Indigenous seeds include the seeds of those plants that are naturally adapted to an area where the intended use is for the revegetation of disturbed sites. These species include grasses, forbs, shrubs, and legumes.” The Contractor must supply the Engineer with all seed bag tags and a certification from the supplier stating that the seed complies with the Federal Seed Act and the Montana Seed Laws (MCA 80-5-101 through 305).

##### 2. INDIGENOUS SEED

- A. All seed shall comply with and be labeled in accordance with the Montana Seed Law. MCA 80-55-104(2) states:
  - “Indigenous seeds, as defined in 80-5-101, in amounts of 1 pound or more, whether in package or bulk, must be labeled with the following information.”
  - (a) ...the statement “labeled only for reclamation purposes”;
  - (b) ...lot number or other distinguishing mark;
  - (c) ...the common name, species and subspecies, when applicable, including the name of each kind of seed present in excess of 5 percent. When two or more kinds of seed are named on the label, the label shall specify the percentage of each. When only one kind of seed is present in excess of 5 percent and no variety name of type designation is shown, the percentage must apply to seed of the kind named. If the name of the variety is given, the name may be associated with the name of the kind. The percentage in this case may be shown as “pure seed” and must apply only to the seed of the variety named;
  - (d) state or country of origin;
  - (e) the approximate percentage of viable seed, together with the date of test. When labeling mixtures, the percentage viability of each kind shall be stated;
  - (f) the approximate percentage by weight of pure seed, meaning the freedom of seed from inert matter and from other seeds;

- (g) the approximate percentage by weight of sand, dirt, broken seeds, sticks, chaff and other inert matter;
  - (h) the approximate total percentage by weight of other seeds;
  - (i) the name and approximate number of each kind of species of prohibited and restricted noxious weed seeds occurring per pound of seed;
  - (j) the full name and address of the person, firm or corporation selling the seed.
- B. As listed in the Montana Seed Law, seed shall contain no “PROHIBITED” noxious weed seed. The seed shall contain no “RESTRICTED” noxious weed seed in excess of the maximum numbers per pound as specified by MCA 80-50-105 or as specified by the appropriate County Weed Board, whichever is more stringent. The number of seed allowed per pound, for all other noxious weed seeds shown on the “restricted list” will be zero.
- C. Seed shall be grown in the North American continent above 41 degrees north latitude. Known varieties whose origin is above the 41<sup>st</sup> parallel but grown below are acceptable. All seed shall be a standard grade adapted to Montana conditions. Seed that has become wet, moldy, or otherwise damaged will not be accepted.
- D. Calculations of pure “live seed” may be made on the basis of either a germination test or a tetrazolium test in addition to the purity analysis. Seed shall be applied on a pure “live seed” basis. The quantity of pure “live seed” in a 100-pound container shall be determined by the formula: 100 multiplied by germination percentage and this product multiplied by the purity percentage. (For example, if the seed is 85 percent pure and test 90 percent germination, then a 100 percent container would contain 76.5 pounds of pure “live seed.”)

### 3. SEED CERTIFICATION

- A. Seed certification shall be submitted to the Engineer prior to any seeding. The Contractor shall also submit a copy of the bill or other documentation from the seed supplier showing actual bulk weights of the individual seed types combined in the mix. The required certifications and documentation shall be provided to the Engineer at least three days prior to seeding.

### 4. SUBMITTALS

- A. The Contractor shall provide the following submittals in accordance with project submittal requirements:
  - 1. Fertilizing and seeding Equipment and Methods.

## PART 3 SEED RATE

### 1. GENERAL

- A. The following application rates for seed are based on the drill seeding method. When the broadcast seeding method or the hydraulic seeding method is used, the application rates listed below must be doubled at no additional cost to the Owner:

BLUEWATER HATCHERY  
TILLET SPRING CAP PROJECT

SEEDING  
02/931

1. Upland Area Seed Mix

Common Name	Seed Mix (lb. PLS/acre)*
Western Wheatgrass	10.0 lbs.
Thickspike Wheatgrass	8.0 lbs.
Hard Fescue	6.0 lbs.
Slender Wheatgrass	4.0 lbs.
Green Needle Grass	4.0 lbs.
<b>Total</b>	<b>32.0 lbs.</b>

**PART 4 SEEDING PREPARATION**

1. GENERAL

- A. Areas to be seeded shall be completed, in reasonable conformity, to specified line and grade prior to seeding and approved by the Engineer.
- B. Slopes and areas shall be topsoiled and permanently seeded. The contractor must obtain resident Engineer's permission to commence topsoil placement and seeding operations. Slopes and areas shall be topsoiled in accordance with the Cover Soil Specifications, and mulched or otherwise treated in accordance as specified herein. Application rates for permanent seeding are shown in this specification under Seed Rate.
- C. Seeding of the finished slopes shall require repeated seeding operations until approved by Resident Engineer, and shall not be construed to mean that the required finishing, topsoiling, mulching, and seeding may be done only once. Any additional move-in required will not be paid for separately.
- D. It is necessary, insofar as it is practical and feasible, that the seedbed surface, at the time of application of seeds, not be excessively wet, snow-covered, or frozen and be reasonably free of large lumps, clods, and impervious crusts of dirt; that there be no appreciable areas of loose soils which can feasibly be compacted; that the surface, to a depth of approximately 4 inches, not be so tightly compacted that seed cannot begin growth. The Contractor shall treat such areas, to attain, as nearly as practical, the condition described.
- E. If seeding is hampered due to standing vegetation, the vegetation shall then be mowed and left lay after seeding. Mowing shall be done, where terrain permits, with equipment using a cutting blade which rotates in a plane parallel to the ground. Whether alive or dead, the vegetation shall be removed if it will prevent good seeding practice.
- F. Excessively tight or compacted soils shall be loosened to the minimum depth of 4 inches. Discing, harrowing, or tilling of the soil shall be done at right angles to the natural flow of water on the slopes, unless otherwise approved by the Engineer. Compaction of the soil when required shall be performed by equipment which will produce a uniform rough textured surface ready for seeding and mulching. Compacting of loose soils may be required by the Engineer.

## **PART 5 SEED DISTRIBUTION**

### **1. GENERAL**

- A. Seed shall be applied to the conditioned seedbed no longer than 48 hrs after the seedbed has been conditioned. Broadcast or hydraulic seeding methods shall not be used during adverse weather as determined by the Engineer. The applied seed, regardless of the method of application, shall not be covered by a soil thickness greater than ½ in. in depth.
- B. Seeding by Drill: Seeding equipment used for applying grass seed must be designed, modified or equipped to regulate the application rate and planting depth of grass seed. If equipment for sowing cover crop seed is not equipped with press wheels, the seed shall be compacted with a cultipacker immediately after the ground has been drilled. Seed must be uniformly distributed in the drill hopper during the drilling operation. Acceptable drills are: custom seeders, furrow drills, disc drills, or no till drills, All seeding equipment shall be operated normal to the slope drainage.
  - 1. Planting depth shall be regulation by depth bands or coulters. The drill box shall be partitioned by dividers no more than 24 inches apart, in order to provide for more even distribution on sloping areas. A drill shall be no wider than the width of the area over which it is to operate.
  - 2. The rows of planted seed shall be a maximum of 8 inches apart and shall be at right angles to the natural slopes.
- C. Broadcast Seeding: Seeding by hand or mechanical broadcasting will be permitted on areas inaccessible to drills or impractical to seed by other prescribed methods. Broadcast seeding requires the approval of the Engineer.
  - 1. Broadcast seeding shall be carried out in wetland areas.
  - 2. Areas receiving broadcast seeding shall be drug with chains or implement approved by the Engineer in order to ensure that the seed is covered.
- D. Hydraulic Seeding: Hydraulic seeding equipment may be used. Seed and mulch will be applied in separate and distinct operations except for the following:
  - 1. When using the hydraulic seeding method, the Contractor must provide 1 pound of wood fiber or organic mulch per each 3 gallons of water in the hydraulic seeder as a cushion against seed damage. The mulch used as a cushion may be part of the total required mulch with the remainder applied after the seed is in place.
  - 2. After blending, the slurry shall be applied to the seedbed within 45 minutes after the seed has been added to the water. If the slurry cannot be applied within the specified 45 minutes, it shall be fortified, at no cost to the Owner, with the correct ratio of seed to the remaining slurry and a new 45-minute time frame established for applying the fortified mixture.

3. The Contractor will be required to use extension hoses to reach the extremities of slopes.
4. The Contractor shall remove any equipment tracks on the seedbed prior to final mulching. The Contractor shall use a rake, small harrow, or other acceptable means to remove the tracks.

## **PART 6 TRACKING**

### **1. GENERAL**

- A. Tracking will be required on hydroseeded or broadcast areas where mulch crimping cannot be accomplished and where hydromulching will be accomplished. Exceptions will be allowed for small areas (0.1 ac.) not accessible to hydroseeding equipment.
- B. Tracking shall be accomplished using a tracked vehicle equipped with grousers sufficient to groove the surface to at least ½ inch. The tracking vehicle shall be operated so as to completely cover the surface with grouser marks. All grousers marks shall run perpendicular to the natural slopes. The tracking vehicle shall be operated alternately between forward and reverse on each pass to eliminate damage to the seedbed resulting from 180 degree skid turns.
- C. If the area is seeded by hydraulic methods, tracking of the slopes shall be done at such time when the surface has had sufficient time to dry. The length of time established will be at the discretion of the Engineer.

## **PART 7 SEEDING DATES**

### **1. GENERAL**

- A. Seeding shall be performed no longer than 48 hours after seedbed has been conditioned.

**END OF SECTION 02/931**

## **SECTION 02/932**

### **MULCH**

#### **PART 1 GENERAL**

##### **1. DESCRIPTION**

- A. This work shall consist of covering and processing specified seeded areas with a mulch of the stipulated materials. Mulch shall be applied to all project areas requiring revegetation. All construction disturbed areas shall be revegetated, including road right-of-ways; and, excluding the installed roadways, buildings, and the tank.

##### **2. SUBMITTALS**

- A. The following submittals are required in accordance with the project submittal requirements:
  - 1. Manufacturer's specifications and material content for mulch products.
  - 2. Manufacturers recommended application methods and rate.
  - 3. Vegetative mulch source and weed-free certification.

##### **3. MULCH TYPE AND RATE**

- A. The Contractor shall use Vegetative Mulch, or Wood Fiber Mulch and Tackifier.
- B. Vegetative Mulch: A grass hay or straw mulch shall be applied at a rate of 2,000 pounds per acre in those areas which are to be seeded with the Seed Mix. Grass hay or straw mulch shall be anchored by a mulch tiller (crimper).
- C. Wood Fiber Mulch shall be applied at a rate of 2,000 pounds per acre in those areas which are to be seeded.
- D. Tackifier shall be applied with all hydromulched areas at the manufacturer's recommended rate of 40 pounds per acre for slopes flatter than 2:1 and 80 pounds per acre for slopes 2:1 or steeper.

##### **4. VEGETATIVE MULCH**

- A. This type of mulch material shall be composed of grass hay, wheat straw, rye straw, or barley straw, in that order of preference.
- B. Grass Hay: This type of mulch material shall be composed primarily of perennial grasses at least 10 inches. The grass hay mulch shall contain greater than 70 percent grass by weight and shall not contain greater than 10 percent alfalfa, crested wheatgrass or yellow sweet clover. Grass hay is subject to the submittal review process and must be "Montana Noxious Weed Seed Free Hay" provided by a certified supplier.

- C. Straw: This type of mulch material shall be clean grain straw, at least 10 inches, shall be “Montana Noxious Weed Seed Free” straw and shall not contain greater than 5 percent cereal seed by weight, (i.e., seed heads). Written confirmation from a certified supplier will be required.
- D. Chopped or ground material is not acceptable. The mulch material is not acceptable if it is musty, moldy or rotted, or if it contains seedbearing stalks of noxious weeds. It shall be free of stones, dirt, roots, stumps or other foreign material.

5. WOOD FIBER MULCH

- A. Wood fiber mulch shall consist of specially prepared wood fibers and shall be processed in such a manner that it will not contain any growth or germination inhibiting factors. Fiber shall not be produced from recycled material such as sawdust, paper, cardboard, or residue from pulp and paper plants. The fiber shall be dyed an appropriate color to facilitate visual metering during application. The mulch shall be of such a consistency that after being combined in a slurry tank with water and other approved additives, the fibers in the material will be uniformly suspended to form a homogeneous slurry. During application the material shall produce a mat-like net covering the grass seed. Wood fiber shall be supplied in packages. Each package shall be marked by the manufacturer to show the air-dry weight content. If requested by the Owner, the Contractor shall submit a signed statement certifying that the material furnished has been laboratory and field-tested and that it meets requirements and intents specified. Wood fiber mulch shall be as manufactured by Weyerhaeuser Company or approved equal.

6. TACKIFIER

- A. Tackifier shall be a biodegradable organic formulation processed specifically for the adhesive binding of mulch. The tackifier shall uniformly disperse when mixed with water and not be detrimental to the homogeneous properties of the mulch slurry. Any tackifier which has been moisture damaged or damaged by other means will not be acceptable. Tackifier may be added either during the manufacturing of the mulch or incorporated during mulch application.
- B. Organic soil and mulch tackifier for use in hydraulically planting of grass seeds, flowers, or wood tree seeds, or stolon, either alone or in combination with fertilizer, wood fiber mulch and other approved additives, shall consist of specifically blended compatible hydrocolloids. Starch-based tackifiers are unacceptable.
- C. The soil and mulch tackifier shall be supplied in easily disposable packages containing 5, 20, or 40 pounds of material having an equilibrium air-dry moisture content at time of manufacture of 8 percent, plus or minus 2 percent, with a minimum water-holding capacity of 6-1/2 times by weight of dry material.
- D. The organic soil and mulch tackifier shall have the additional characteristics of hydrating and dispersing in circulating water to form a homogeneous slurry and remain in such a state in the hydraulic mulching unit, or adequate equal, with the specified, or other approved materials.

- E. Soil and mulch tackifier shall be applied at a minimum rate of 40 pounds per acre on slopes 2:1 or flatter, or at 80 pounds per acre or more on slopes steeper than 2:1, or at submitted manufacturer's recommendations.
- F. When applied, the organic soil and mulch tackifier shall form a loose chain-like protective film, but not a plant inhibiting membrane, which will allow moisture to percolate into the underlying soil, while helping "stick" seeds, fertilizer and other specified materials to the soil surface during germination and initial seedling growth, after which the organic soil and mulch tackifier shall break down by microbial action.

## 7. GENERAL CONSTRUCTION

- A. Mulch, when required, must be applied to seeded areas not more than 24 hours after seeding regardless of the type used. If the Contractor does not mulch within 24 hours after seeding, the Contractor may be required to re-seed the project at no additional cost to the Owner. Mulch shall not be applied in the presence of free surface water, but may be applied upon damp ground. Mulch shall not be applied to snow-covered ground surfaces.
- B. Mulch shall not be applied to areas having a substantial vegetative growth, such as grasses, weeds and grains. Mulching shall not be done during adverse weather conditions or when wind prevents uniform distribution. Application, if after seeding, shall be in a manner to not seriously disturb the seedbed surface. All roadway structures and facilities shall be protected and kept undamaged from application of bituminous material and other operations. Any such material deposited on such structures or facilities shall be removed, at the expense of the Contractor.
- C. Additional mulching may be required in accordance with summer erosion control procedures as noted in the Fertilizing and Seeding Technical Section (02/931).
- D. The Contractor shall remove any equipment tracks on the seedbed prior to final mulching. The Contractor shall use a rake, small harrow, or other acceptable means to remove the tracks.

## 8. APPLICATION OF VEGETATIVE MULCH

- A. Vegetative mulch shall be applied after seeding and fertilizing is completed. The mulch shall be applied in a uniform manner by a mulch spreader, at the rate specified. The mulch spreader shall be designed specifically for this type of work. The vegetative material shall be fed into the mechanical mulch spreader at an even, uniform rate.
- B. When asphalt or a tackifying agent is used as a binder for vegetative mulch, it shall be applied at the rate specified. It shall be evenly distributed over the vegetative material as it emerges from the blower discharge or it may be hydraulically applied directly following mulch application. Uneven distribution, caused by inadequate power or improperly adjusted equipment, poor workmanship, erratic material feed or discharge, or similar causes within the Contractor's control, shall be corrected. The quantity of asphalt

or tackifying agent specified is subject to increase or decrease as determined in the field by the Engineer.

- C. Straw or native hay shall be uniformly spread at the rate specified. Unless otherwise authorized by the Engineer, straw or hay shall be anchored into the seedbed by using a mulch crimper. Straw or hay shall have a minimum length of 10 inches and shall be pliable. If straw breaks during crimping, it shall be sprinkled with water, not soaked, to facilitate placement.
- D. The mulch crimper, specifically designed for this type of work, shall have round, flat (not angled), notched blades of these approximate dimensions:  $\frac{1}{4}$  inch thick by 18 inches in diameter and spaced 8 inches apart. The crimper shall have sufficient weight to force the vegetative mulch a minimum of 3 inches into the soil and shall be equipped with disc scrapers. Mulch crimping shall be done on all slopes capable of being safely traversed by a tracked vehicle. All mulch crimping shall be done perpendicular to the flowline of the slope.

9. APPLICATION OF WOOD FIBER MULCH

- A. Wood fiber mulch or organic mulch shall be applied by means of hydraulic equipment which utilizes water as the carrying agent. A continuous agitator action, that keeps the mulching material and approved additives in uniform suspension, must be maintained throughout the distribution cycle. The pump pressure shall be capable of maintaining a continuous non-fluctuating stream of slurry. The slurry distribution lines shall be large enough to prevent stoppage.
- B. The discharge line shall be equipped with a set of hydraulic spray nozzles which will provide an even distribution of the mulch slurry to the seedbed. Mulching shall not be done in the presence of free surface water resulting from rains, melting snow, or other causes.
- C. The Contractor shall start at the top of the slope and work downward. If necessary, he may be required to use extension hoses to reach the extremities of slopes.

**END OF SECTION 02/932**

**SECTION 03/300**  
**STRUCTURAL CONCRETE**

**PART 1 - GENERAL**

1.1 DESCRIPTION

- A. This section defines the use of Structural Concrete for the construction of aeration structures, the diversion structure and the Tillet Spring cover.

**PART 2 - SPECIFICATIONS**

2.1 GENERAL

- A. The following reference specifications shall be used to construct concrete structures:

Montana Public Works Standard Specifications (6<sup>th</sup> Edition)  
Section 03321 - Reinforcing Steel  
Section 03300 – Structural Concrete

**PART 3 – MODIFICATIONS TO REFERENCED SPECIFICATIONS**

3.1 CLARIFICATIONS AND CHANGES TO SPECIFICATIONS

- A. All reinforcing steel shall be Grade 60.
- B. All concrete shall be M-4000 with a maximum aggregate size of ¾-inch.
- C. Maximum water cement ratio for concrete shall be 0.45 by weight.
- D. Mix design shall include a super plasticizer. The maximum slump of the super plasticized mix shall be 8-inches.
- E. Concrete shall not be air entrained.

3.2 PVC WATERSTOP

- A. PVC waterstop shall be added to the specifications. Water stop shall be 9-inch, center bulb, Greenstreak catalog item #778 or approved equal. Install per manufacturers recommendations.

### 3.3 CONCRETE SAMPLING AND TESTING

A. Concrete sampling and testing shall be as specified below:

1. For all poured in place concrete structures:
  - a. Take one (1) sample each pour and test air content each pour.
  - b. Make three (3) test cylinders per sample.
  - c. Break 1<sup>st</sup> cylinder at 7 days – minimum strength 2700 psi.
  - d. Break 2<sup>nd</sup> cylinder at 28 days – minimum strength 4000 psi.
  - e. Break 3<sup>rd</sup> cylinder at 28 days only if 1<sup>st</sup> 28 day break fails.

Contractor shall be responsible for sampling concrete and making cylinders, transporting cylinders to a certified testing laboratory and sending copies of the concrete strength reports to the Owner. Air content for each sample shall also be on reports.

All costs for concrete sampling and testing shall be paid for by the Contractor and included in the bid prices to complete the work.

### 3.4 EPOXY GROUTED REINFORCING

A. Epoxy grout to be used where drilling and epoxy grouting is called for on the drawings shall be Fastenal Propoxy 300 two part grout, or approved equal. Drilled holes shall be brush cleaned and air blasted to remove all concrete dust. Follow the manufacturer's written instructions for grouting procedures.

### 3.5 CONCRETE STAIN/DYE AND SEALANT

A. Concrete Dye/Stain

1. Concrete stain/dye shall be UV stable, water based color, penetrating stain. The stain/dye shall not contain acid or harmful toxins.
2. The stain/dye shall be applied in a minimum of 2 coats. Apply stain per manufacturer's recommendations.
3. The color shall be Owner select.
4. Concrete stain/dye shall be Colorfast as produced by L&M Construction Chemicals, Inc. or approved equal.

B. Sealant

1. Sealant shall be blush resistant, non-yellowing, low VOC, water based acrylic curing and sealing compound.
2. Concrete sealant shall be Lumiseal FX as produced by L&M Construction Chemicals, Inc. or approved equal.
3. Apply sealant per manufacturer's recommendations.

C. Concrete dye/stain and sealant shall be applied to all exposed exterior surfaces of poured in place concrete, precast hollow core panels and shotcrete.

3.6 MEASUREMENT AND PAYMENT

- A. Part 4: Measurement and Payment shall be removed from all specifications listed in section 2.1.A.

**END OF SECTION 03/300**

## **SECTION 03/305**

### **LEAK TESTING**

#### **PART I WATER LEAK TESTS**

##### **1. PURPOSE**

- A. Work necessary to determine integrity of finished concrete and to show liquid storage tanks do not leak.
- B. Testing shall be performed by the Contractor and observed by the Engineer or Owner.

##### **2. ALL LIQUID HOLDING STRUCTURES**

- A. Perform leakage tests after concrete has cured and obtained its design strength, and before backfill or other work which will cover concrete wall surfaces is begun, including exterior tar.
- B. Fill with water to maximum liquid level shown prior to leak testing, and maintain level for 48 hours for moisture absorption by concrete.
- C. Close all valves to the structure and or isolate piping using muni-balls and measure the change in water surface for a 24-hour period.
- D. During test period, examine exposed portions of structure for dampness or leaks and mark visible leaks or damp spots.

##### **3. TEST EVALUATION CRITERIA**

- A. Drop in water surface in 24-hour period with basin full is less than 1/10 of 1 percent of normal volume of liquid contained in water-holding structure, after accounting for evaporation and precipitation in open basins and damp spots or seepage are not present on walls or other areas exposed to view.
- B. Determine evaporation by floating an evaporation pan in structure during test period.

##### **4. EXCESSIVE LEAKAGE AND LEAKAGE FAILURE**

- A. If drop in water surface exceeds test evaluation criteria or if damp spots or seepage is visible in exposed surfaces.

##### **5. REPAIRS**

- A. If leakage exceeds specified limit or if damp spots and observed seepage is present on exposed surfaces, drain water-holding structure, epoxy inject all leaking cracks, patch all surface areas and damp spots previously marked, and make necessary repairs and retest basin.

6. RETEST

- A. Refill liquid-holding structure and test for leakage until structure meets test criteria.
- B. Successful Test: If leakage limit criteria is met and damp spots and seepage problems are corrected.

**END OF SECTION 03/305**

## SECTION 03/330

### STRUCTURAL SHOTCRETE

#### PART 1 - GENERAL

##### 1.1 DESCRIPTION

- A. This section of the specifications covers the application of structural shotcrete required for the following items of work on this project.

1. End closures of cores in precast panels for the Tillet Spring cover.
2. Filling keyway joints between hollow-core panels.

##### 1.2 SUBMITTALS

- A. Cement product information
- B. Sand gradation
- C. List of Equipment
- D. Workers experience (see section 2.3)

#### PART 2 - MATERIALS

##### 2.1 SHOTCRETE MATERIALS

- A. Cement – Cement shall be Portland cement conforming to the ASTM Designation C 150. Cement shall be Type II.
- B. Sand – Sand shall consist of clean, hard, durable, uncoated grains free from lumps, soft or flaky particles, organic matter, loam or other deleterious substances. Sand shall be free from salt and alkali. Fine aggregate shall be well graded from coarse to fine, and when tested by means of laboratory sieves, shall meet the following requirements:

Passing a standard 3/8-inch sieve	100%
Passing a standard No. 4 sieve	95-100%
Passing a standard No. 8 sieve	65-90%
Passing a standard No. 16 sieve	45-75%
Passing a standard No. 30 sieve	30-50%
Passing a standard No. 50 sieve	10-22%
Passing a standard No. 100 sieve	3-8%
Weight removed by elutriation test shall not exceed	3%
Moisture content	3-6%

- C. Water – Water used in shotcrete shall be reasonably clear and free from oil, acid, alkali and vegetable substances.

## 2.2 EQUIPMENT

- A. The shotcrete equipment used shall conform to the following general requirements and shall in all respects be capable of continuously producing and placing a shotcrete concrete which is fully satisfactory for the work and acceptable to the Engineer. Acceptance of the equipment may be revoked by the Engineer at any time that the results of the shotcrete work appear to be unsatisfactory, or at any time the equipment appears to be in need of repair.
1. Mixer: The shotcrete equipment shall include standard concrete rotating mixing equipment capable of thoroughly dry-mixing the sand and cement for uniformly and continuously supplying the mixed material to the gun. Mixers shall not be loaded above capacity for which the mixer is designed. The mixers shall be equipped with a suitable device for accurately measuring the sand and cement for each batch by volume (or by weight if the Contractor prefers) and shall also be equipped with a hopper for receiving materials without loss of cement or sand.
  2. Pneumatic Mixing Chamber and Delivery Equipment: This portion of the equipment shall be of such design that it can receive recharges of cement and sand from the rotary mixer, thoroughly mix them with compressed air and deliver them uniformly and continuously into the delivery hose. The equipment shall preferably be of the double chamber type. The first chamber shall receive and pressurize the dry-mix and deliver it to the second chamber. The second chamber shall have a suitable feeder and be of sufficient size so that it can continuously furnish all of the required material to the delivery hose while the first chamber is being charged. The equipment shall be kept in good condition at all times to avoid reduced operating pressure and reduced velocity of material delivery. The interior of drums, feed gearing and valves shall be cleaned as often as necessary to avoid material from caking on critical parts.
  3. Air Compressor: The air compressor shall be of sufficient capacity and in good condition so as to provide, without interruption, the pressures (without fluctuations), and volume of air necessary for the longest hose delivery. In determining compressor capacity, allowance should be made for the air consumed in blowing away rebound, cleaning reinforcement and for other incidental uses.
  4. Water Pump: The equipment shall include a storage tank and suitable water pump to provide a uniformly steady (nonpulsating) supply of water at a pressure of at least 15 psi above the highest air pressure required for placing, unless an adequate supply of water at ample pressure is available from some other source.
  5. Hose and Nozzle: Hose in good condition shall and of ample size and strength for the nozzles and pressures shall be used. Nozzles shall be 3/4-inch or 1 1/4-inch, depending on which size is most suitable for the various parts of the work. Unless otherwise authorized in writing, nozzles shall be of the “pre-mixing” type with a perforated water feed inside the nozzle to direct an even distribution of water through the material at the place of application. The nozzle linings shall be promptly replaced when worn to the point of uniformity where flow is lost.

## 2.3 QUALIFICATION OF WORKMEN

- A. It is recognized that satisfactory construction using shotcrete is very highly dependent on the skill of the workmen, including the shotcrete foreman, the nozzelman, the helpers and the gunman. Before starting work, the Contractor shall furnish to the Engineer, in writing, evidence that each of the key workers to be utilized in the shotcrete work has had sufficient training and experience in shotcrete work to fully qualify to properly perform the work.

The foreman shall have had good personal experience in shotcrete work and shall be thoroughly capable of directing all phases of the work. He shall preferably have had at least two (2) full years of work as a nozzleman. He shall have a thorough understanding of the operation of the equipment being used and the particular application problems involved.

## PART 3 - EXECUTION

### 3.1 PREPARATION FOR APPLICATION OF SHOTCRETE

- A. All surfaces of hollow-core panels to receive shotcrete shall be clean and free of dirt, dust, grime, or other debris. Keyway joints between hollow core panels shall be blasted with compressed air if necessary to remove all lodged or trapped particles.

### 3.2 PROPORTIONING SHOTCRETE MIXES

- A. Shotcrete shall be proportioned with one part of cement to 4 ½ parts of sand when measured by volume, making allowance for bulking. If measured by weight, the mix shall be determined to provide the volumetric proportions just as measured. No adjustment of the mix outside of these proportions shall be permitted except with special written permission of the Engineer. All lumps or particles over 3/8-inch in size shall be removed by screening before placing the mixture in the hopper of the "cement gun".

### 3.3 MIXING

- A. Sand and cement shall be mixed in such quantities as are required for immediate use. The materials shall be mixed for a sufficient period of time to thoroughly blend the sand and cement into a uniform material. This mixture shall be carried on for not less than 2 minutes after sand and cement are in the drum, when the drum rotates at a peripheral speed of about 200-feet per minute. Each batch should be entirely discharged before any recharging is begun.

The mixer should be cleaned at regular intervals (at least every 8 hour shift), thoroughly enough to remove all adherent material from the mixing vanes and from the drum.

No water shall be added to the mix at any time, except by injection in the gun. Mixed material that has stood for 45 minutes without being used shall be rejected. Remixing or tempering shall not be permitted.

### 3.4 APPLICATION

- A. Nozzle Location: Generally, the nozzle shall be held perpendicular to the surface to which the shotcrete is being applied with the nozzle being held three to four feet from the surface and moved in a narrow range to produce a spreading effect over a small area. In confined areas where working room is cramped, it may be necessary to use the nozzle in a position dictated by the local conditions.
- B. Adjustment of Nozzle: If the flow of material at the nozzle is not uniform, and slugs, sand spots, or wet “sloughs” result, the nozzleman shall turn the nozzle away from the work until the faulty conditions are corrected. Any resulting defects in the work shall be cut out and repaired as the work progresses.
- C. Sequence of Application: Providing rebound is properly cleared away from the work, the nozzleman may work either from the bottom to top or vice versa. Corners shall be filled first.
- D. Thickness of Applications: Some latitude will be allowed in the thickness that may be applied at one time dependent on the particular conditions and on the skill of the workers. On vertical surfaces, thickness shall be kept thin enough that no sagging occurs (generally about an inch). On horizontal surfaces being shot from above, the thickness shall be limited so that spatter does not occur and so that other evidence of too much moisture is not found.
- E. Time between Coats: The time interval between successive applications must be sufficient to allow initial, but not final set to develop, unless otherwise permitted by the Engineer.
- F. Removal of Defective Work: If during the placement of shotcrete, obvious defects such as sand deposits, sagging areas, voids, or other faulty materials or workmanship are evident, the shotcrete shall be cut away and removed before final set has occurred. Shotcrete shall be reapplied to such areas as soon as practicable and the defective areas are suitably repaired.

### 3.5 FINISHING AND CURING

- A. On completing any surface, the nozzleman shall bring the shotcrete to an even plane and to well-formed corners by working up to the ground wires or other thickness or alignment guides, using a somewhat lower placing velocity.
  - 1. Surface Uniformity: Surfaces shall appear true and reasonably uniform after the application of shotcrete is complete. Generally, shotcrete surfaces should be brought by spraying within 3/8-inch of the lines and grades defined. Removal of surface irregularities and defects shall be accomplished by hand finishing techniques.
  - 2. Hand Finishes: Concrete surface finish requirements for shotcrete shall be generally as specified for poured structural concrete.

3. Curing: Curing requirements for shotcrete construction shall conform to the specifications for structural concrete.

### 3.6 STRENGTH REQUIREMENTS AND TESTING

- A. Test cylinders shall be taken at the rate of 2 cylinders for the project. Each cylinder shall be dated, numbered, and the name of the nozzleman noted. Test cylinders shall be made by shooting shotcrete into a mold of hardware cloth (about 3/4-inch mesh) to make cylinders 6-inches in diameter and 12-inches long. The excess material outside the mold shall be trimmed off with a sharp edged trowel. About 24 hours after making the cylinders, the hardware cloth form shall be removed and the cylinders delivered to an independent testing laboratory for moist curing at 70 degrees F. One cylinder shall be tested at the age of 7 days and shall develop a compressive strength of at least 2000 psi, and the other shall be made at the end of 28 days and shall develop at least 3000 psi. If any of the cylinders fail to meet the above requirements, the Engineer may require the Contractor to have core samples taken by a private testing laboratory and tested. All costs involved in preparing cylinders and transporting them to the laboratory shall be borne by the Contractor. Lab testing costs will be paid by the Contractor.

### 3.7 REPLACEMENT OF WORK

- A. All work which is rejected by the Engineer due to poor strength, cracking or other sufficient cause shall be removed as directed and replaced in a satisfactory manner.

**END OF SECTION 03/330**

## **SECTION 03/360**

### **PRECAST CONCRETE HOLLOW CORE SLABS**

#### **PART 1 - GENERAL**

##### **1.1 DESCRIPTION**

- A. This section covers the design, manufacture, delivery, erection and installation of precast, prestressed hollow core slabs as shown in the drawings.

##### **1.3 STANDARDS AND CODES**

- A. Work shall be completed in accordance with ACI Standard 318, Building Code Requirements for Reinforced Concrete, and shall comply with local building code requirements.

##### **1.4 SUBMITTALS**

- A. The precast, prestressed hollow core slabs shall be designed by the Manufacturer for the spans and loading conditions specified on the drawings and in the specifications. Design calculation shall be submitted to the Engineer for review and approval. Design submittal shall bear the stamp and signature of a State of Montana Registered Professional Engineer experienced in precast, prestressed concrete design.
- B. The Contractor shall submit shop drawings and erection drawings. Drawings shall include the number and size of prestressing strands, prestress force, blockouts, mark numbers and other details necessary of the manufacture and installation of hollow core slabs.

#### **PART 2 - PRODUCTS**

##### **2.1 PRECAST HOLLOW CORE SLABS**

- A. Precast, prestressed hollow core slabs shall be machine extruded, with continuous open cores, in a casting yard under closely controlled mixing, placing and curing conditions. The slabs shall be furnished in nominal 4-foot widths, and sawn to lengths shown in the drawings. Special slabs with skewed ends or narrower widths shall be cut to the proper dimensions by the manufacturer.
- B. Hollow core slabs shall be produced by a firm with at least (5) continuous years of experience in the manufacture of precast, prestressed hollow core units.
- C. Concrete mix shall be designed by the Manufacturer as required for proper operation of the production equipment. Concrete shall have a minimum compressive strength of 4,000

psi at the time of detensioning, and 8,000 psi at twenty-eight days. When required, concrete compressive strength shall be determined with a calibrated rebound test hammer in accordance with ASTM specification C-805.

- D. Cement shall conform to ASTM Specification C-150.
- E. Aggregates shall conform to ASTM specification C-33 or C-330.
- F. Prestressing strands shall be 7-wire, uncoated high-tensile strength strand in conformance with ASTM specification A-416.
- G. Shotcrete for pouring end closures at the ends of the panels and filling keyways between the panels shall be as specified in specification 03/330 Structural Shotcrete.
- H. Rough openings and blockouts required for structural connection of hollow core slabs shall be provided as shown in the drawings. Blockouts shall be provided for penetrations 8-inches or greater in diameter or width. Penetrations less than 8-inches in diameter or width shall be field cut by the Contractor. Opening and/or cutting of prestressing strand shall be approved by the Engineer and Manufacturer prior to execution.
- I. Hollow core slabs shall be fabricated at a PCI-Certified Plant, with an established quality control program. Each unit shall be inspected prior to delivery and shall be clearly marked by the quality control inspector as approved for use in construction.
- J. Hollow Core Slabs shall comply with the following tolerances:
  - 1. Length:  $\pm 3/8$ -inch
  - 2. Width:  $\pm 1/4$ -inch
  - 3. Depth:  $\pm 1/4$ -inch
  - 4. Position of open core:  $\pm 1/4$ -inch vertical and horizontal
  - 5. Minimum Cover over tendons:  $\pm 1/2$ -inch to core,  $\pm 1$ -inch to bottom
  - 6. Differential camber between adjacent member of same design and length: not greater than  $1/4$ -inch after field leveling
  - 7. Squareness of ends:  $\pm 3/8$ -inch

### **PART 3 – EXECUTION**

#### **3.1 ERECTION**

- A. Contractor shall lift, handle, place and install hollow core slabs in accordance with manufacturer's recommendations. Hollow core slabs shall be set with the minimum end bearing shown on the plans.
- B. All hollow core slabs shall be leveled within specified tolerances before grouting the longitudinal joints or pouring end closure concrete. Shores or other leveling devices shall not be removed until the grout has attained a minimum strength of 2000 psi.
- C. All slabs shall bear on a  $1/8$ -inch by 4-inch neoprene strip or other Engineer approved elastomeric pad.

- D. Field cutting of hollow core slabs shall not be done without prior approval of the Engineer and Manufacturer. Approved cutting or drilling shall be accomplished in accordance with the Manufacturer's written recommendations.

### 3.2 CONCRETE STAIN/DYE AND SEALANT

- A. Apply concrete stain/dye with sealant to all exposed surfaces of precast hollow core panels and shotcrete as specified in technical specification 03/300 structural concrete after panels are in place and shotcrete has been applied.

**END OF SECTION 03/360**

## **SECTION 06/450**

### **FIBERGLASS GRATING**

#### **PART 1 GENERAL**

##### **1. SECTION INCLUDES**

- A. Work necessary to furnish and install fabricated grating and grating anchorage.

##### **2. SUBMITTALS**

###### **A. Product Data:**

- 1. Catalog information and catalog cuts.
- 2. Manufacturer's specifications, to include coatings.
- 3. Installation instructions.

###### **B. Shop Drawings:**

- 1. Grating: Show dimensions, weight, and size, supports, and other work.

###### **C. Quality Control Submittals:**

- 1. Manufacturer's certification of compliance for specified products.

##### **3. DELIVERY, STORAGE, AND HANDLING**

###### **A. Preparation for Shipment:**

- 1. Insofar as is practical, factory assemble items provided hereunder.
- 2. Package and clearly tag parts and assemblies that are of necessity shipped unassembled in a manner that will protect the materials from damage, and facilitate identification and final assembly in the field.

###### **B. Storage and Handling: In accordance with manufacturer's recommendations.**

#### **PART 2 PRODUCTS**

##### **1. GENERAL**

- A. Like Items of Materials: Provide end products of one manufacturer in order to achieve standardization for appearance, maintenance, and replacement.

B. Design and Fabrication:

1. Meet minimum dimensional requirements as shown or as specified.
2. Field measure areas to receive grating, verify dimensions of new fabricated supports, and fabricate to dimension required for specified clearances.
3. Section Length: Sufficient to prevent its' falling down through clear opening when oriented in the span direction when one end is touching either the concrete or the vertical leg of grating support.
4. Minimum Depth of Grating: 1-1/2-inches.
5. Minimum panel weight shall be 40 lbs, unless secured in place. Maximum panel weight shall be 90 lbs. Panels less than forty lbs shall be secured in place with stainless steel hardware per manufacturers recommendations.

C. Grating Supports:

1. Seat angles and beams where shown, all structural shapes shall be FRP construction, gray color.
2. Support beams and angles shall be Dynaform ISOFR structural shapes as manufactured by Fibergrate Composite Structures, Inc. or approved equal.
3. Grating embedment angles shall be "y" style with a leg designed for concrete embedment. Embedment angles shall be Dynaform Traditional 'Y' Angle as manufactured by Fibergrate Composite Structures, Inc. or approved equal.

2. FOOT TRAFFIC GRATING

- A. Uniform Service Load: 100 psf minimum, unless otherwise shown.
- B. Maximum Deflection: 0.34-inch, unless otherwise shown.
- C. Space bearing bars at 1-1/2-inch center-to-center bottom grid, 3/4-inch center-to-center top grid
- D. Provide grit top surface for traction.
- E. Maximum allowable open area: 44%
- F. Fiberglass molded grating: Micro-Mesh 1-1/2-inch x 3/4-inch square top mesh grating as manufactured by:
  1. Fibergrate Composite Structures, Inc;
  2. Or **ENGINEER** approved equal.
- G. Color: gray

### **PART 3        EXECUTION**

#### **1.        INSTALLATION**

- A.        Provide equipment for lifting and placing as necessary.
- B.        Install in accordance with approved shop drawings, and as shown and as specified.
- C.        Install plumb or level as applicable in locations as shown.
- D.        Completed Installation: Rigid and neat in appearance.
- E.        Commercially Manufactured Products:
  - 1.        Install in accordance with manufacturer's recommendations as approved.
  - 2.        Secure grating to support members with fasteners.
  - 3.        Welding is not permitted.
  - 4.        Fasteners: Field locate and install.
  - 5.        Permit each grating section to be easily removed and replaced.
- F.        Clearance Between Ends of Grating Sections and Vertical Surfaces of Supports or Concrete Walls: ¼-inch
- G.        Replace grating sections not meeting specified or detailed dimensional requirements.

**END OF SECTION 06/450**

**SECTION 08/305**  
**ACCESS HATCHES**

**PART 1 - GENERAL**

1.1 DESCRIPTION

- A. This section covers the materials, fabrication, and installation of metal access hatches for valve vaults and similar applications.

1.3 GENERAL

- A. All hatches shall be designed for the application indicated on the Plans. Dimensions indicated on the Plans are nominal dimensions. The Contractor shall provide the rough opening size required for the installation of each hatch.

1.4 SUBMITTALS

- A. The Contractor shall submit detailed drawings indicating the type of hatch to be used at each location the method of installing the hatch, hatch characteristics including dimensions, materials, framework, hardware and other pertinent features of the hatch, and the type of coating, when required, to be provided.

**PART 2 - MATERIALS**

2.1 ALUMINUM HATCHES

- A. Hatches shall be constructed of aluminum plate with extruded aluminum frames. Floor hatches shall be required to withstand a 300 psf live load and roof hatch covers shall be designed to withstand a 40 psf live load. Channel frames shall be ¼ - inch aluminum with an anchor flange around the perimeter. Doors shall be with an anchor flange around the perimeter. Doors shall be oriented as shown on the Drawings and shall be equipped with stainless steel hardware throughout, including hinges, pins, spring operators, etc. All hatches shall have positive locking spring operators, etc. All hatches shall have positive locking devices, tension bars or springs to provide ease of operation, hold-open devices, and stainless steel safety chains to span between double doors in their open position.
- B. All pairs of double doors shall be capable of individual opening and closing, including safe automatic hold-open.
- C. Mill finish is required on hatches with thixotropic coal tar coating applied to the exterior of the frame in contact with concrete.

- D. Hatches shall include a recessed padlock hasp.
- E. Hatches shall be equal to Type “J” or Type “JD” aluminum hatches as manufactured by the Bilco Company.
- F. Hinges shall be on the long side of the door opening.

## 2.2 HATCH SCHEDULE

<u>Hatch No.</u>	<u>Type</u>	<u>Dimensions</u>
Tillet Spring Cover	“J”-Aluminum	48-inch x 30-inch Single Door
Tillet Spring Cover	“J”-Aluminum	30-inch x 24-inch Single Door

## PART 3 – EXECUTION

### 3.1 GENERAL

- A. Hatches shall be installed according to the manufacturer’s requirements. Hatches shall be installed plumb and square at the locations indicated on the Plans. Framework shall be cast into concrete openings or securely bolted to framed openings using stainless steel bolts.

Aluminum doors shall not be permitted to be in direct contact with concrete or masonry surfaces. All aluminum framework shall be liberally coated with bituminous material in a manner approved by the Engineer before being installed in contact with concrete or masonry.

No obstructions shall be permitted in or around the hatch area that will interfere with the opening and closing of the doors. Doors shall operate freely and easily and when closed, shall fit true and snug. Warped, racked, or deflected frames will not be permitted or accepted.

Aluminum hatches shall not be coated except as herein provided for installation in concrete or masonry openings.

Drainage connections on floor hatch frames shall be piped to drain as shown in the drawings.

Corners of square hatch openings fitted over round openings shall be suitably sealed with concrete and finished smooth in such a manner that will not interfere with the door operation.

**END OF SECTION 08/305**

## **SECTION 11/230**

### **AERATION COLUMNS**

#### **PART 1 - GENERAL**

##### **1.1 DESCRIPTION**

- A. This section covers the materials, fabrication, and installation of aeration columns for treatment of hatchery supply water.

##### **1.2 GENERAL**

- A. All aeration columns shall be designed for the application indicated on the Plans.

##### **1.3 SUBMITTALS**

- A. The Contractor shall provide submittals including shop drawings, catalog cuts, installation instructions, and operating and maintenance instructions.

#### **PART 2 - MATERIALS**

##### **2.1 AERATION COLUMNS**

- A. All aeration column shall be provided by a single manufacturer. The manufacturer shall be a recognized manufacturer of aeration column specifically for aquaculture and have at least five years of experience in this field.
- B. Aeration column shall be sized and configured as shown on the drawings. Aeration columns shall be as manufactured by WMT – Water Management Technologies or approved equal.
- C. Aeration column aerators shall be able to operate with efficient water distribution and resist phase inversion at loading variances between 50 and 160 gpm per square foot.
- D. The column shall be constructed entirely of FRP. Fabrication shall comply with ASTM D3299 and ASTM 4097.
- E. Distributor plate assemblies shall have chimneyed vents with a total height as required to prevent water flow into the chimney. The number and size of vents shall be designed by the manufacturer.
- F. The top of the column shall be covered, except for the chimney vents.
- G. Aeration shall be achieved by using multiple splash plates set at equal intervals throughout the height of the column. The number and spacing of splash plates shall be

determined by the manufacturer. Splash plates shall be supported by stainless steel threaded rod.

- H. The column shall include a 20-inch diameter side inspection port, with a bolted FRP cover centered vertically in the column.
- I. Aeration columns shall include FRP supports.
- J. All support and connection hardware shall be stainless steel 304.
- K. The piping connection shall be an FRP flange, sized and drilled to match a 16-inch diameter class 150 flange. Provide stainless steel flange bolts and 1/8-inch neoprene gasket for the connection.

### **PART 3 – EXECUTION**

#### **3.1 FABRICATION AND INSTALLATION**

- A. Aeration columns fully fabricated at the manufacturer's shop and shipped to the project site as a unit. Installed aeration columns in accordance with manufacturer's recommendations.

**END OF SECTION 11/230**

## SECTION 15/060

### EXPOSED PIPING - GENERAL

#### PART 1 GENERAL

##### 1. WORK INCLUDED

- A. This section covers the work necessary to furnish and install exposed piping and as further specified in the Detail Piping Specifications.

##### 2. GENERAL

- A. Like items of material provided hereunder shall be the end products of one manufacturer.
- B. Piping and appurtenances require coating per section PAINTING, except as specified herein.

##### 3. SUBMITTALS

- A. The following information shall be provided:
  - 1. Product Data: Furnish the following:
    - a. Catalog information of products manufactured to ASTM, AWWA or similar standards or described by a manufacturers name and model.
    - b. Framing Support Systems: Detailed installation drawings, catalog information, and complete component specifications.
  - 2. Shop Drawings: Furnish the following:
    - a. Support System:
      - 1) Drawings of each piping system to the scale as shown, locating each support, hanger, guide and anchor including seismic bracing.
      - 2) Identify support, hanger, guide, and anchor type by catalog number and shop drawing detail number.
    - b. Shop Fabricated Piping: Pipe design calculations and detailed shop drawings including:
    - c. Detailed pipe sections, special fittings and bends, showing dimensions, coatings and other pertinent information.
    - d. Layout drawings showing location of each pipe section and each special length; number or otherwise designate laying sequence on each piece.
  - 4. Manufacturer's Certification of Compliance: Submit for the following manufactured items and materials to certify compliance with the specifications:
    - a. Structural design for piping and support systems.
  - 5. Hydrostatic Testing:
    - a. Detailed plan for filling and testing pipeline sections; submit at least (30) days in advance of testing.
    - b. Testing procedures to be used, locations for necessary equipment and

- materials, and date and duration of tests.
    - c. Logs of testing indicating time, pressures and results.
  - 6. Cleaning and Disinfection:
    - a. Detail plan for cleaning.

## **PART 2 PRODUCTS**

### **1. GENERAL**

#### **A. Pipe Materials**

- 1. General materials to be used for the piping system are shown on the Drawings.
- 2. Specific material requirements are specified in the Detail Piping Specifications following this Section.

#### **B. Galvanizing:**

- 1. No galvanized materials are allowed on this project

#### **C. Appurtenances:** All fittings, couplings, valves, and other appurtenances shall be rated for the same or higher design pressure as the pipe to which they shall be joined and shall withstand the test pressure without damage.

### **2. PIPE SUPPORT SYSTEMS**

#### **A.** Pipe support systems shall be the equivalent of a “unistrut” frame system with a pipe clamp. The system shall be structurally designed. Provide manufacturer verification the frame will withstand the weight of the piping filled with water.

- 1. Manufacturers and Figures:
  - a. Anvil International
  - b. **ENGINEER** approved equal.

#### **B.** Coatings shall be a powder coated paint system, green in color. Any coated components shall be stainless steel.

#### **C.** Concrete Attachment: ½-inch x 4-1/2-inch stainless steel 304 expansion anchors, Hilti KB3 or approved equal

## **PART 3 EXECUTION**

### **1. EXAMINATION**

#### **A.** Verification of Existing Pipe and Penetrations:

- 1. Prior to ordering materials, examine all existing pipes which are to be connected to the work.

2. Verify the size, material, joint types, elevation, horizontal location, and pipe service of existing pipes.

## 2. PREPARATION

### A. Pipe and Fittings:

1. Inspect before exposed pipe or fitting is installed.
2. Clean ends of pipe thoroughly, remove foreign matter and dirt from inside of pipe, and keep clean during and after installation or laying.

### B. Damaged Coating:

1. Repair damaged areas in field with material equal to original.

## 3. PIPING INSTALLATION-GENERAL

### A. General: Install in conformance with reviewed shop drawings.

### B. Pipe Fittings and Appurtenances: In accordance with the manufacturer's instructions and these Specifications.

## 4. PIPING SUPPORT SYSTEMS

### A. General:

1. Install in accordance with manufacturer recommendations.
2. Support piping connections to equipment by pipe support and not by the equipment.

## 5. EXPOSED PIPING INSTALLATION

### A. General:

1. Install parallel to building lines, unless shown otherwise

### B. Pipe Flanges:

1. Set level, plumb, and aligned.
2. Install flanged fittings true and perpendicular to the axis of the pipe.
3. Bolt holes shall straddle vertical centerline of pipes.

### 4. Plastic Flanges:

- a. Bolt up using a filler gasket at any joint with a raised face.
- b. The filler gasket shall bear the bolt load uniformly and remove the flange moment from that part of the flange protruding beyond the outer edge of the raised face.

C. Valve Orientation:

- 1. As shown where valve handwheels are shown.
- 2. Where valve handwheels are not shown, orient to permit easy access to the valve operator, and to avoid interferences.

6. PIPE LEAK TESTING - GENERAL

A. General:

- 1. Conduct pressure and leakage tests on newly installed pipelines and appurtenances, in accordance with reviewed testing plan.
- 2. Furnish necessary equipment and material and make taps in piping, as necessary for testing and as specified.
- 3. **ENGINEER** will observe the tests.
- 4. Provide 5 days advance written notice of start of testing to **ENGINEER**.
- 5. Test Pressure shall be 50 psi.
- 6. Test Records: Make records of each piping system during the test to document the following:
  - a. Date of test.
  - b. Description and identification of piping tested.
  - c. Test fluid.
  - d. Test pressure.
  - e. Remarks, including:
    - 1) Leaks (type, location).
    - 2) Repairs made on leaks.
  - f. Certification by **CONTRACTOR** and signed acknowledgment by **ENGINEER** that tests have been satisfactorily completed.

- B. Exposed Pressure Piping: Conduct tests after piping has been completely installed and inspected for proper installation including all supports, hangers, and anchors, but prior to installation of insulation.

7. HYDROSTATIC LEAK TESTING

A. Testing Equipment:

- 1. Quantity                      Equipment
- 2                                      Graduated containers

2 Pressure gauges  
1 Hydraulic force pump  
As required suitable hose and suction pipe

B. Procedure:

1. Use water as the hydrostatic test fluid.
2. Provide clean test water of such quality to prevent corrosion of the materials in the piping system.
3. Maximum Velocity During Filling: 0.25 foot per second applied over full area of pipe.
4. Open vents at all high points of the piping system to purge air pockets while the piping system is filling.
5. Venting during filling may also be provided by loosening flanges with a minimum of four bolts or by the use of equipment vents.
6. Test all parts of the piping system at the test pressure specified.
7. Maintain hydrostatic test pressure continuously for 30 minutes minimum and for such additional time as necessary to conduct examinations for leakage.
8. Examine all joints and connections for leakage.
9. The piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leaking.
10. Correct visible leakage and retest as required by **ENGINEER**.
11. Leave pipe full of water after repair of leaks.

8. FINAL CLEANING

A. Interim Cleaning:

1. Prevent accumulation of weld rod, weld spatter, pipe cuttings and filings, gravel, cleaning rags, and other foreign material within piping sections during fabrication.
2. Examine piping to assure removal of these and other foreign objects prior to assembly and installation.

B. Following assembly and testing, and prior to disinfection and final acceptance, flush pipelines (except as stated below) with water to remove accumulated construction debris and other foreign matter.

C. Flush until all foreign matter is removed from the pipeline.

- D. Provide hoses, temporary pipes, ditches, and other items as required to properly dispose of flushing water without damage to adjacent properties.
- E. Minimum Flushing Velocity: 2.5 fps.
- F. For large diameter pipe where it is impractical to flush the pipe at 2.5 fps velocity, clean the pipeline in-place from the inside by brushing and sweeping, then flush the line at a lower velocity.
- G. Insert cone strainers in the flushing connections to attached equipment and leave in-place until cleaning has been accomplished.
- H. Remove accumulated debris through drains 2 inches and larger or by removing spools and valves from piping.

**END OF SECTION 15/060**

## **SECTION 15/060-02**

### **DETAIL PIPING SPECIFICATION POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS**

#### **PART 1 - GENERAL**

##### **1.1 SCOPE**

- A. Products and methods described herein are supplemental to products and methods specified in Section EXPOSED PIPING – GENERAL.

#### **PART 2 - PRODUCTS**

##### **2.1 PIPE**

- A. PVC, ½-inch through 12-inch, Schedule 40, conforming to ASTM D 1784 and ASTM D 1785.

##### **2.2 NIPPLES**

- A. Same as pipe.

##### **2.3 JOINTS**

- A. Socket-weld, except where connecting to unions, valves, and equipment with threaded connections or flanges that may require future disassembly.

##### **2.4 FITTINGS**

- A. Schedule 40, as specified under PIPE above. Fittings shall conform to the requirements of ASTM D 2466 for socket type.

##### **2.5 FLANGES**

- A. One piece, molded hub type flat faced flanges, 125-pound standard, as specified under FITTINGS hereinbefore.

##### **2.6 GASKETS**

- A. Full-faced, 1/8-inch thick, fabricated from neoprene.

- B. When mating flange has raised face, use flat ring gasket and provide filler gasket between OD of raised face and flange OD to protect PVC flange from bolting moment.

## 2.7 BOLTING

- A. Bolts shall be fabricated in accordance with ANSI B18.2 and provided with washers of the same material as the bolts.

## 2.8 SOLVENT CEMENT

- A. All socket connections shall be joined with PVC solvent cement conforming to ASTM D564. Manufacture and viscosity shall be as recommended by the pipe and fitting manufacturer to assure compatibility.

# PART 3 – EXECUTION

## 3.1 GENERAL

- A. See Section EXPOSED PIPING – GENERAL.
- B. All rigid PVC pipe shall be cut, made up, and installed in accordance with the pipe manufacturer's recommendations. Buried plastic pipe shall be laid by snaking the pipe from one side of the trench to the other. Offset shall be as recommended by the manufacturer for the maximum temperature variation between time of solvent welding and during operation.
- C. Provide adequate ventilation when working with pipe joint solvent cement.

**END OF SECTION 15/060-02**

## **SECTION 15/101 VALVES**

### **PART 1 GENERAL**

#### **1. WORK INCLUDED**

- A. This section covers the work necessary for furnishing and installing the butterfly valves in the hatchery building.

#### **2. SUBMITTALS**

- A. The following specific information shall be provided:
  - 1. Product Data:
    - a. Complete specifications, dimensions, data and catalog cuts or drawings shall be submitted for all valves.
  - 2. List any exceptions taken to these Specifications.

### **PART 2 PRODUCTS**

#### **1. GENERAL**

- A. All valves shall be complete with all necessary operators, actuators, handwheels, chain wheels, extension stems, floor stands, worm and gear operators, operating nuts, chains, wrenches, and other accessories or appurtenances which are required for the proper completion of the work. Operators, actuators, and other accessories shall be sized and furnished by the valve supplier and factory mounted.
- B. Valves shall be suitable for the intended service. Renewable parts including discs, packing, and seats shall be of types recommended by valve manufacturer for intended service, but not of a lower quality than specified herein.
- C. Valves and operators shall be suitable for the exposure they are subject to, buried, interior or exterior, as applicable. They shall have all safety features required by OSHA.
- D. Unless otherwise shown, valves shall be the same size as the adjoining pipe.
- E. All units shall have the name of the manufacturer and the size of the valve cast on the body or bonnet or shown on a permanently attached plate in raised letters.
- F. For the purpose of designating the type and grade of valve desired, a manufacturer's name and list or figure number is given in the following specifications. Valves of equal quality by other manufacturers will be considered.

#### **3. DESIGN FEATURES**

- A. Valve ends shall be as specified, as shown on the Drawings, and to suit the adjacent piping.

#### 4. VALVE OPERATORS

- A. General: All valves shall be equipped with operators. The valve operator types, as specified herein, describe only the general characteristics of the operator. The operator shall be compatible with the valve with which it will be used and shall be of the same manufacturer, or a product that is recommended by the valve manufacturer. The operator shall be sized to operate the valve for the full range of pressures and velocities imposed by the service. All valve operators shall open by turning counter-clockwise.

- B. Manual Operators:

- 1. General:

- a. Manual handwheel operators shall be provided unless otherwise shown or specified. Lever operators may be supplied on quarter-turn type valves 4 inches and smaller, if recommended by the manufacturer; however, operator force shall not exceed 40 pounds under any operating condition, including initial breakaway.
    - b. When the maximum force required to operate a valve under full operating head exceeds 40 pounds, gear reduction operators shall be provided. Gear operators shall be totally-enclosed and lubricated.
    - c. On quarter-turn valves, the valve operators shall be of the self-locking type to prevent the disc or plug from creeping and shall be provided with position indicators to show the position of the valve disc or plug.
    - d. Operators of the worm and gear type shall have self locking wormgears, one-piece design, of gear bronze material, accurately machine cut. The worm shall be hardened alloy steel, with thread ground and polished. Operators of the geared traveling nut type shall have threaded steel rods with internally threaded bronze or ductile iron nut.

- 2. Exposed Operators:

- a. Exposed operators shall be furnished with chain wheel operators geared operators, extension stems, floor stands, and other elements as shown on the Drawings to permit operation from the normal operating level.

#### 6. VALVES

- B. Single Entry PVC Ball Valves:

- 1. Ball valves 2-inches and smaller, for general water service, shall be single entry, heavy bodied PVC construction, with PTFE ball seats and EPDM O-rings. Valves shall be solvent weld connection with minimum 150 psi pressure rating. Valve operator shall be quarter turn shut off with polypropylene handles. Valve shall be as manufactured by Spears Manufacturing Company or **ENGINEER** approved equal.

C. PVC Wafer Style Butterfly Valves:

1. PVC Butterfly Valves shall be wafer style, PVC body, with EPDM seats. Valves shall be gear operated with a polypropylene handwheel and shall include a position indicator. The valve disc shall be offset design with type 316 stainless steel stem. Valve bolt hole pattern shall be class 150, pressure rating shall be 150 psi minimum. Valve shall comply with AWWA C504. Valves shall be as manufactured by Spears Manufacturing Company or **ENGINEER** approved equal.

## **PART 3 EXECUTION**

### **1. GENERAL**

- A. Boltholes of flanged valves shall straddle the vertical centerline of the pipe run. Prior to installing flanged valves, the flange faces shall be thoroughly cleaned. After cleaning, insert gasket and bolts, and tighten the nuts progressively and uniformly. If flanges leak under pressure, loosen or remove the nuts and bolts, reseal or replace the gasket, retighten and/or reinstall the nuts and bolts, and retest the joints. Joints shall be watertight at test pressures before acceptance.
- B. Thoroughly clean threads of screwed joints by wire brushing, swabbing, or other approved methods. Apply approved joint compound to threads prior to making joints. Joints shall be watertight at test pressures before acceptance.

### **2. PLACING**

- A. Generally, unless otherwise indicated on the Drawings, all valves installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above the finish floor shall be installed with their operating stems vertical. Valves installed in horizontal runs of pipe having centerline elevations between 4 feet 6 inches and 7 feet above the finish floor shall be installed with their operating stems horizontal, unless otherwise shown on the Drawings. If adjacent piping prohibits this, the stems and operating handwheel shall be installed above the valve horizontal centerline as close to horizontal as possible. Valves installed in vertical runs of pipe shall have their operating stems orientated to facilitate the most practicable operation.

### **3. TESTING**

- A. Valves shall be field tested at the same time that the adjacent pipeline is tested. Joints shall show no visible leakage under test. Any joint exhibiting leakage shall be repaired prior to final acceptance. If there are any special parts of control systems or operators that might be damaged by the pipeline test. They shall be properly protected. The **CONTRACTOR** will be held responsible for any damage caused by the testing.
- B. All valve operators shall be tested under pressure to confirm free operation without binding after connections to piping are completed.

**END OF SECTION 15/101**